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The Railroad Men's Reading Room, at Sayre, Pa., was opened Feb. 4, with appropriate exercises. This room, with its equipment, was tendered by Mr. O. O. Esser, Superintendent of the Pennsylvania & New York Division of the Lehigh Valley R. R., for the free use of the employees of the railway and the citizens during the year 1896. There are nearly 2,000 employes of the Lehigh Valley R. R. located at Sayre, and they have heretofore been without the advantages of a resort of this kind, and those present received the gift with enthusiasm and made a fitting acknowledgment to the superintendent. The room is on the second floor of the passenger station, convenient of access, is well furnished, heated by steam and lighted by electricity, and will seat about 150 people. A large number of periodicals have already been presented by friends of the project; the list of railway and engineering publications being particularly complete A library, in connection with the reading room, has been started in the room adjoining, and a good beginning has a ready been made towards a supply of books. It is the intention to have a series of practical talks in the reading room on topics of interest to railway men, and such other exercises for instruction and entertainment as can be arranged for. The advantages of such accommodation have been very generally recognized by railway companies, and the enthusiastic opening in this case promises well for the success of this praiseworthy undertaking. The example might well be followed by railways generally, where the number of men assembled is sufficient to warrant such a movement, and where the Railway Branch of the Young Men's Christian Association has not as yet established quarters on the same plan.

A heavy tank engine, with eight wheels, all coupled, has been built at the Columbus, O., shops of the Pittsburg, Cincinnati, Chicago & St. Louis R. R., to work as a pusher on the Madison Hill grade, which rises 413 ft. in a length of 7,012 ft., and this was operated by a rack rail locomotive from 1848 till 1868. The engine weighs 70 tons on a wheelbase of 15 ft. 6 ins., and has driving wheels 4 ft. 2 ins. diameter and cylinders 22x28 ins. The tanks extend along the sides of the boiler and carry about 2,000 gallons of water. The engine was designed by Mr. S. P. Bush, Superintendent of Motive Power.

Progress on the Siberian railway, made during 1895, is reported as follows by United States Consul-General Karel, at St. Petersburg: In the year 918 miles were constructed, making a total of 1,649 miles now completed, or over one-third of the entire line. There is now a direct railway route connecting St. Peterburg with the Yenisasi River, a distance of 3,056 miles. Mr. Karel says that there is to be a railway ferry across the 20 miles of Lake Baikal, and that efforts are being made to avoid the northern Vladivostock route by extending the line across Chinese Manchuria. If political events do not interfere, this southern line would be shorter, less expensive in construction, pass through a dense population and lead to a harbor always unobstructed by ice

A four-cylinder compound locomotive, as designed by Mr. George Strong, of New York, with a view to avoiding the counterbalance weights in the driving wheels, is being built by the Maryland Steel Co for the Balanced Locomotive & Engine Co. The engine will also have two of Mr. Strong's corrugated furnaces in place of the ordinary firebox.

A sand bed for the stub track of a derailing switch is being used on the Saxony State Railways with good results. The rails of the stub track are lower than those of the main or side track, and are buried in sand, the top of which is flush with the higher rails. The sand is from 2 ins. to 5 ins. deep, and acts very effectually in quickly but gradually retarding the car.

A pile driver for driving piles to a considerable depth below the staging or deck of structure is being made by Sissons & White, of England. It has leaders sliding on the fixed leaders of the pile driver frame, guided by a chain passing over a drum on the engine and over pulleys on the top and bottom of the sliding leaders. The pile may be driven till its head is 30 ft. below the main leaders. The machine has been used on marine and harbor work, for docks, etc., at Grimsby and Hull, England; on the Manchester Ship Canal and at Buenos Ayres, in the Argentine Republic.

A report made to the Metropolitan Traction Co., of New York city, by the President, Mr. Vreeland, shows that the company now has 164 miles of single track, of which 25.34 miles are operated by cable, 6.78 by underground electric conductors and 131.88 miles by horses. The net earnings of the one-fifth of the mileage which is operated by mechanical traction were, in 1895, so large as to carry the entire investment. Mr. Vreeland says: "It is not only through an increase of business that this is brought about, but also through economy in operation. When the entire traction system was operated with horses the cost of operation was 70% of the gross receipts. The substitution of mechanical traction upon 20 miles of 12% reduced the cost of operation of the entire system to 54.39 %. The cost of operating the Broadway road was reduced from 66 to 38 % by the substitution of mechanical traction for horses. These figures indicate very plainly what may be expected of this system when it shall be supplied with mechanical traction throughout and be in other respects fully developed."

Steel rails on highways, to reduce the resistance to traction, are suggested in the annual message of the Governor of New Jersey, the cost being estimated at $6,000 per mile for a double track on a macadamized road, and $2,000 for a single track on a road built for light traffic. The plan suggested is similar to that described in our issue of Dec. 19, 1895.

The cost of clean streets in New York, in 1895, as compared with 1894, is thus set forth in a letter of Street Cleaning Commissioner George E. Waring, Jr., to Mayor Strong:

	1894.	1895.
Removing snow and ice...	$89,155 09	$217,820 83
New stock.....	111,807 63	85,853 51
Total expenditures.....	2,366,524 02	2,704,979 19

The excess of expenditures in 1895 over 1894 was about 12½ %; but if the rental of the Barney refuse dumping boats be equalized over both years at the same rates, the work of 1895 would only have cost 9% more than that for 1894. The items for snow removal and renewal of stock are not included in the above statements of totals, and Commissioner Waring leaves the citizens to judge whether they received any more value for the expenditure for snow removal than in the year before. He figures that the total cost of street cleaning, amounts to 3 cents per week per head of population.

Steel towers, resting upon masonry foundations extending 20 ft. above the water line, are planned for the new East River bridge by the Chief Engineer, Mr. L. L. Buck. The reasons advanced are that the stone towers to would require wider foundations and a much longer time to build, and would not permit as good an arrangement of tracks as the towers proposed. The steel towers, with four pillars, would be less costly and they could be re-enforced if future traffic should demand it. The latest estimate of the cost of the bridge is $8,000,000, exclusive of the approaches, which may cost $4,000,000 more. An attempt is also being made to reduce the clear height of the bridge from 150 ft. to 135 ft., the same as the Brooklyn and Blackwell's Island bridges. As generally described, the bridge will be of the suspension type with 1,700 ft. span between the towers and 800 ft. in the shore spans. The total width of the bridge will be 118 ft., with six railway tracks and two 20-ft. roadways, and two 24-ft. footways above the roadways. It is expected that plans will be sufficiently advanced to permit the commencement of work in July next.

The most serious railway accident of the week was a head collision between a passenger train and a freight train near Wetang, Ill., on the Illinois Central R. R., Feb. 11. The passenger train had orders to stop at Wetang, but tried to reach Dongola before the freight train. Four men (the enginemen and firemen) were killed.——Another serious accident which occurred during the week was the derailment of a passenger train on the Cincinnati & Muskingum Ry. near Crooksville, O., Feb 10. The cause of the accident is said to have been a switch left partly open by a section man who had been cleaning snow away from the switch. The engine, tender, and combination baggage and mail car went down a 15-ft. embankment, and the smoking car was derailed. The baggage master was killed and eight persons were seriously injured, the engineer and mail clerk being probably fatally crushed.——A rear collision, due to an open switch, occurred Jan. 30 at Manly, N. C., on the Seaboard Air Line. A freight train had taken the side track to let another freight train pass, but the switch had been left open. Two trainmen were killed and two injured, while 17 cars were derailed and a number of livestock killed.

The old bridge carrying the New York & New England R. R. across the Pequatuck river, between Bristol and Forestville, Conn., collapsed during the flood and storm of Feb. 6. The bridge was under repair at the time, and three of the men at work upon it were drowned.

A water main on Franklin Ave. hill, Cleveland, O., burst Feb. 11, and the flood caused a washout on the Erie R. R., resulting in the derailment of a train.

A boiler exploded in the Ann and Hope Mill, at Providence, R. I., on Feb. 10, killing two men and injuring others.

One of the boilers belonging to the electric light company in Bennington, Vt., exploded on Feb. 5, demolishing the boiler house and almost ruining the dynamo house. Two men were fatally injured.

The reclamation of land at Muskego Lake, in Waukesiar county, Wisconsin, undertaken by the Wisconsin State Land and Improvement Co., has been practically completed. About 18,000 acres have been reclaimed, of which the company gets 3,200 acres, the balance being the property of farmers, but which were formerly valueless swamp land. A drainage district was organized in 1888, and a canal 20 ft. wide and 6 ft. deep was dug through Muskego Lake and Wind Lake, this depth being eventually increased to 10½ ft., and lateral channels being cut so as to more thoroughly drain the land.

The Hudson River tunnel, say press despatches, is again under consideration in an attempt to complete it. A syndicate of English and American capitalists is being formed, and Sir W. D. Pearson, representing the English bondholders, is now in this country on this business. Daniel Lord, of Lord, Day & Lord, New York city, represents the American interest. The sum of $1,000,000 is mentioned as needed for the immediate resumption of work, but no estimates are furnished covering the completion of the tunnel and its approaches.

A novel form of coal pocket has recently been designed by the Berlin Iron Bridge Co., of East Berlin, Conn., and erected at the power house of the Steinway Electric R. R. Co., at Astoria, N. Y., on the East River, opposite 92d St., New York city. This design is of especial merit in designing a large storage capacity in proportion to the limited amount of oor space occupied. The pocket is cylindrical in form, 28 ft. in diameter, 54 ft. high, and has a capacity of 1,0000 tons of coal. It is built of a skeleton-steel construction, of vertical angle bars and horizontal flat bands, lined with 2-in. tongued and grooved planks. The coal is unloaded from the barge or carts at the side of the pocket, and hoisted by means of a bucket to the top of the pocket, an ordinary hoisting engine furnishing the power. More elaborate mechanical appliances might, of course, be introduced for the work, such as an endless chain or link-belt conveyor, but the saving of labor over that used by the bucket hoist would scarcely pay the interest on the extra cost over the simpler apparatus in the case of any plant of moderate size. There is an opening in the side of the pocket, near the base, for removing the coal in the ordinary way, so that it can be carried into the boiler room by means of an endless chain, with buckets, or by hand barrows.

A new smokeless powder for the 13-in. breech-loading rifled guns was tested at Washington, D. C., on Feb. 6. With 200 lbs. of the explosive a velocity of 1,570 ft. per second was obtained, with a pressure of only 6 tons per square inch at the breech of the gun. With 300 lbs. a velocity of 2,202 ft. per second was secured, with a breech pressure of 13½ tons per square inch. The regulation full charge for a 13-in. gun is 550 lbs., and the pressure must be less than 15 tons, with a muzzle velocity of 2,200 ft. per second. Further tests are in progress.

CURVED MASONRY DAM AT LITTLE FALLS, N. Y.

The accompanying views, Figs. 1 and 2, show a curved masonry dam built last summer across the Mohawk River at Little Falls, N Y. The structure was designed by Prof. Palmer C. Ricketts, M. Am. Soc. C. E., Director of the Rensselaer Polytechnic Institute, Troy, N. Y., and was constructed under his supervision. It is an excellent example of a dam of great curvature, built on that plan simply because it afforded a more economical site. It was constructed of cut limestone and has the following dimensions: Length of curved part, measured on inner edge, or arc of crest, 336 ft.; total length, 356 ft.; chord of curved part, 286 ft.; versed sine, 75 ft.; greatest height, 16 ft.

THE NEW YORK CYCLE SHOW.

The importance of the bicycle from a social, economic, and even engineering standpoint, is a present day fact. The recent cycle show in Madison Square Garden, New York city, was an impressive illustration of this fact and a fruitful field in which to study current progress in the wheel industry.

Of the innumerable makes of bicycles, for each of which some special features and advantages are claimed by the makers, there is little to be said in detail, since all are practically built upon the same general lines. We may, however, refer to the extensive use of the Mannesmann rolled steel tubing for the frames, and to the fact that the U. S. Projectile Co. is manufacturing drawn steel tubing for bicycle frames. Two frames, however, which are somewhat different from the ordinary frame are those of the Upright Cycle Co. and the Owen Mfg. Co., of New London, Conn., both of which are practically triangular, with the seat at the apex.

A number of tandem bicycles were shown, as well as the side-seated bicycles of the Fox Machine Co., of Grand Rapids, Mich., and the Punnett Cycle Mfg. Co., of Rochester, N. Y., in which the two riders sit on either side of the rear wheel. One of the Columbia tandems was fitted for military use, carrying two rifles, two revolvers, two overcoats, a blanket and a signal staff, all closely packed. A similar machine was fitted with a Colt rapid fire gun mounted on the front part of the frame. The Wolff-American Co. also had two military bicycles (for two men), one having a small muzzle-loader gun and the other a Maxim gun. Among other specialties were a Stirling "giraffe" for show riding, having the seat about 8 ft. above the ground, and two tandems for six riders, one by the Fowler Cycle Mfg. Co., of Chicago, and the other by E. C. Stearns & Co., of Syracuse, N. Y. The Fowler machine is 156 ins. long, with a wheelbase of 125 ins., and weighs 137½ lbs. It has 30-in. wheels, and the gear is 153, there being four driving sprockets.

Among specialties in the driving gear may be mentioned the following: The Phillips bicycle of the Phillips Mfg. Co., of New York, has a gear in which the pedals have a vertical instead of a circular motion, the up stroke being a quick return motion; the U. S. Cycle Improvement Co., of Pittsburg, Pa., showed a bicycle in which the sprocket chain was replaced by side rods connecting crank arms on the driving gear and rear axle. Two or three change gears were shown, giving a high gear for use on good level roads, and a low gear for uphill work, etc.; these included the makes of the Miami Cycle Mfg. Co., of Middletown, O., and the Brown-Lipe Gear Co., of Syracuse, N. Y.

Tricycles, with baskets for parcels delivery, or with a small carriage body seat for children, were exhibited by the Tinkham Cycle Co., of New York, and other makers.

The various bicycle fittings included a number of "sanitary" saddles, some designed to afford ample ventilation and others to follow the movement of the body and legs, so as to afford a uniform and easy support.

In tires the most interesting novelties were two non-pierceable tires, in each of which the outer layer of the tire, which takes the wear, had embedded in it thin strips of steel. It seems altogether probable that the tire of the future will in some way or other be made more durable than the ordinary tires of the present day, and especially if pneumatic tires are to find general application upon vehicles of various classes.

In rims the wooden rim seems to have displaced the steel everywhere, owing doubtless to its greater resilience rather than its relative strength, a good illustration, by the way, of the distinction between these two qualities and its practical importance. One or two makers, however, have ventured to use aluminum rims, an innovation for which nothing good can be said.

Several electric bicycle lamps were shown, but are to be classed merely as curious fads rather than improvements of practical importance. To show the extent to which some makers will go in carrying out a pet idea, it may be mentioned that one of these lamps was fed by a storage battery, and to charge this battery a miniature dynamo was furnished connected to a water motor, to be run from an ordinary house faucet. This is a scheme which would interest those in charge of public water supplies, if it had any promise of general use, which it does not.

An invention which was especially noticeable at the show, and one to be wholly condemned, is the use of colored enamels in place of the solid and durable black. Manufacturers would do much better, in our opinion, and build their reputations on a much surer foundation, if they would turn their attention to securing the most absolutely durable black enamel, such as that with which the Rochester, Allegheny and Cambridge steel conduits are covered, instead of experimenting with fancy colors.

The tendency of the trade towards lower retail prices was one which was not evident at the show - upon the surface. The lowest price which the writer saw marked on a wheel on exhibition was $40. On the other hand, when one reflects on the hundreds of exhibitors, and upon the extent to which the great manufacturers of sewing machines, watches, small arms and similar goods are turning their attention to the bicycle trade, it is evident that it is only a question of time, and probably a short time, when the market will be over-supplied and prices will fall to a point which will permit only an ordinary profit to the maker and retailer.

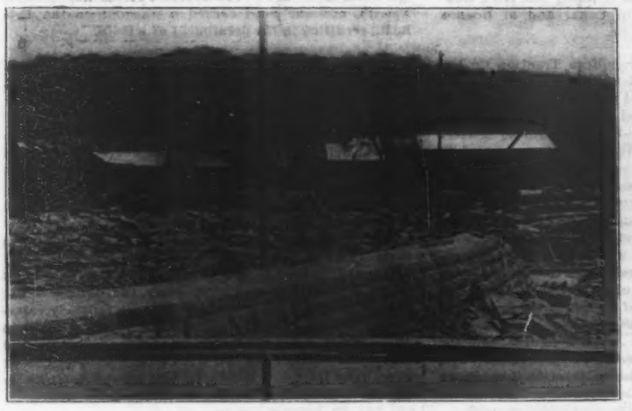

Fig. 1.—View of Dam under Construction.

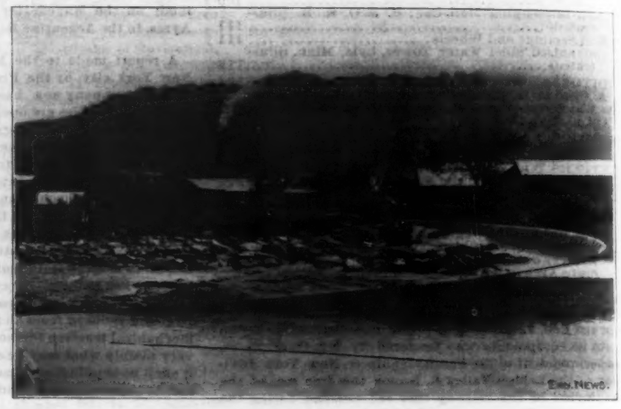

Fig. 2.—View of Dam after Completion.

CURVED MASONRY DAM ACROSS THE MOHAWK RIVER AT LITTLE FALLS, N. Y. Prof. Palmer C. Ricketts, M. Am. Soc. C. E., Engineer.

THE BEAR RIVER IRRIGATION SYSTEM, UTAH.

By W. P. Hardesty, C. E.

(With inset.—Concluded from p. 85.)

At about the 2½-mile point on this section, a wide arroyo is crossed by a 294-ft. flume, shown by Fig. 13, with 28 ft. approaches on each end, making 350 ft. This flume is founded on pile bents, spaced 11 ft., has a clear section of 26 ft. by 6 ft. 7 ins., and is a very substantial structure. The sides are of 2 and the bottom of 3-in. plank. Over 100,000 ft. B. M. of lumber was used in the superstructure, and 2,340 lin. ft. of piles in the substructure. It is of the same general type as the other large flumes.

At the end of the 3½ miles the Malad River is crossed by a flume supported by an iron structure or viaduct 378 ft. long, with wooden approaches of 154 ft. more, making 532 ft. total length. Fig. 14 is a view of this structure, and Fig 15 shows the details of the bridge alone. The regular flume section is 20×7 ft. in the clear, and it is constructed with 14-ft. panels, there being four yokes or frames for each panel, spaced 3½ ft. c. to c. The bottom is of two layers, one of 1-in. and one of 2-in. plank; the sides are of 2-in. plank.

The canal has an incline of 0.7 ft. approaching the east, and a vertical drop of 0.7 ft. at the west end, thus securing a fall of 1.4 ft. and allowing for making the flume level on the viaduct. The iron viaduct and its substructure were built by the Missouri Valley Bridge & Iron Works, of Leavenworth, Kan., which also constructed the Lower Malad flume crossing, mentioned further on. Mr. A. J. Tulloch is engineer and proprietor of the above works, and Mr. A. A. Trocon was the engineer in charge of construction. As the live load of water is 8,750 lbs. per lin. ft., a very strong construction is used. The viaduct consists of five 42-ft. spans and one 70-ft. span, with seven single panel spans of 14 ft. each that take up the space between pairs of columns for bents.

The piers are tubular, of riveted iron filled with concrete, and each founded on four piles 20 ft. long. The two abutments are of masonry, each founded on 27 piles. The trusses are inverted Pratt, with floor beams 3 ft. deep at panel points. The floor is 70 ft. above the bed of the river. The view of this structure, Fig. 14, was taken from the west end, and shows a bridge crossing the canal just beyond. There were 361,400 lbs. of iron and steel, 163 cu. yds. of concrete and masonry, 3,000 lin. ft. of piling and 4,000 ft. of grillage used in the viaduct, while over 100,000 ft. B. M. of lumber was used in the flume itself. The total cost of iron work and sub-structure for this and the other flume mentioned was $27,800, of which about one-fourth went for the latter. For about 1,600 ft. at the east end and 600 ft. at the west end of the viaduct the canal is in 18 to 20 ft. cut, made necessary to secure the favorable crossing place here.

From the Malad flume for over 8½ miles further

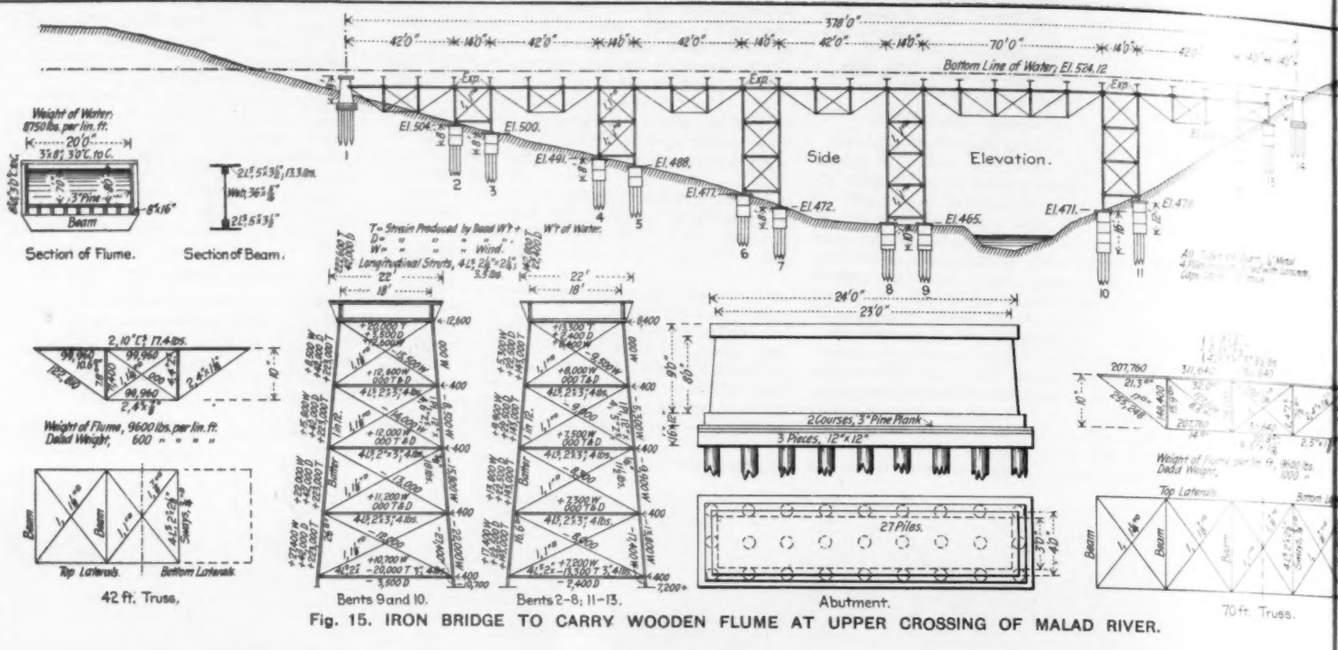

Fig. 15. IRON BRIDGE TO CARRY WOODEN FLUME AT UPPER CROSSING OF MALAD RIVER.

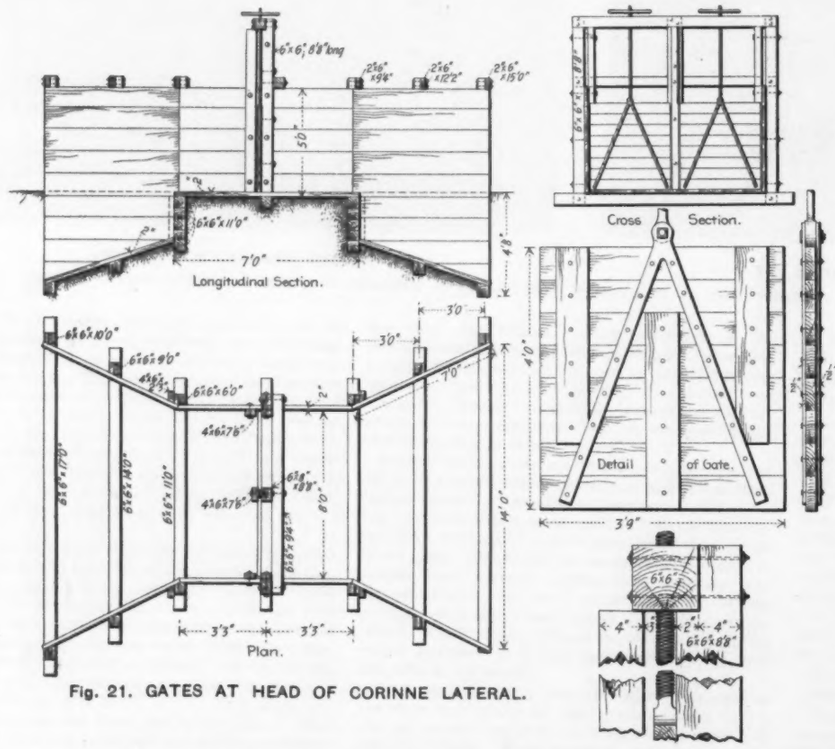

Fig. 21. GATES AT HEAD OF CORINNE LATERAL.

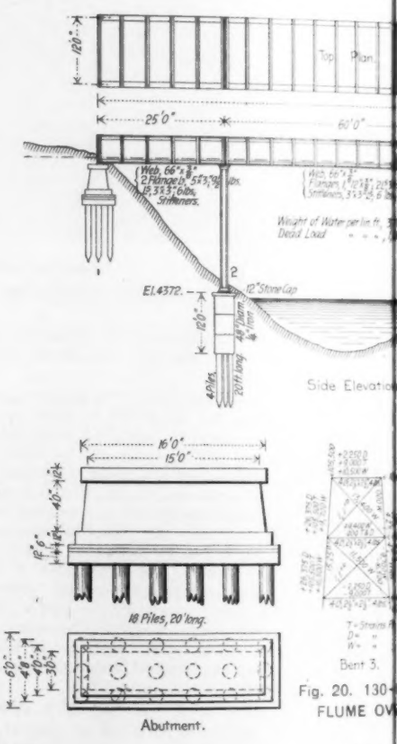

Fig. 20. 130-FLUME OV

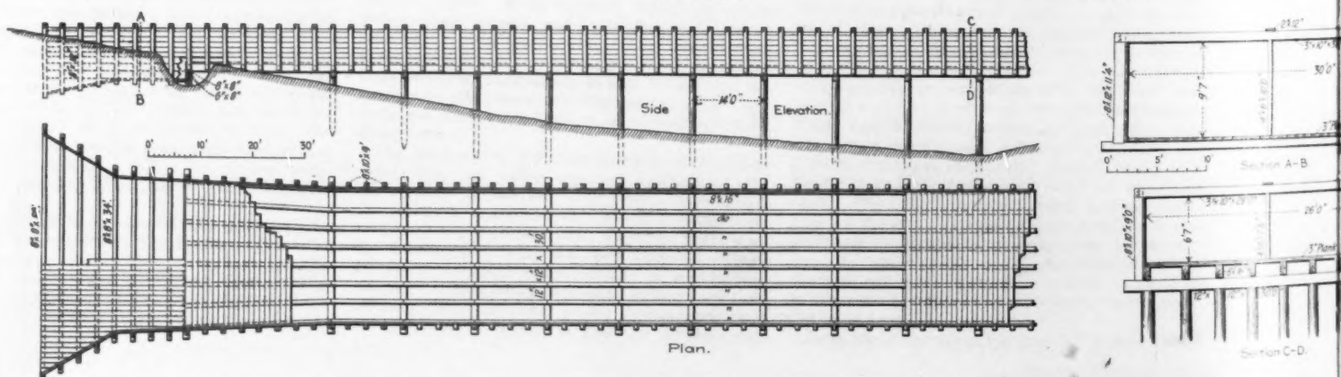

Fig. 13. 294-FT. FLUME WITH TWO 28-FT. APPROACHES ON WEST CANAL; J. C. ULRICH, Designing Engineer.

CORNELL UNIV. OF MICRO
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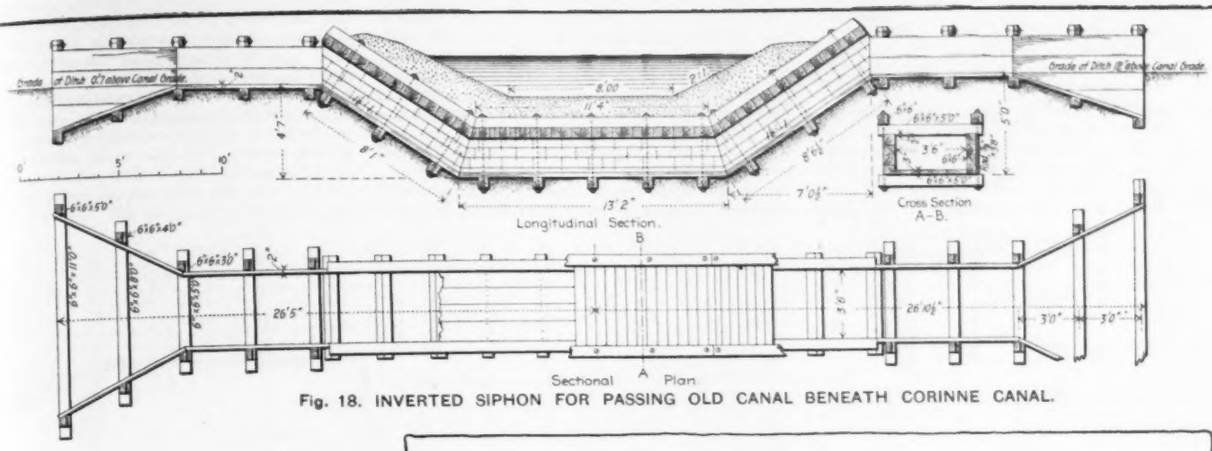
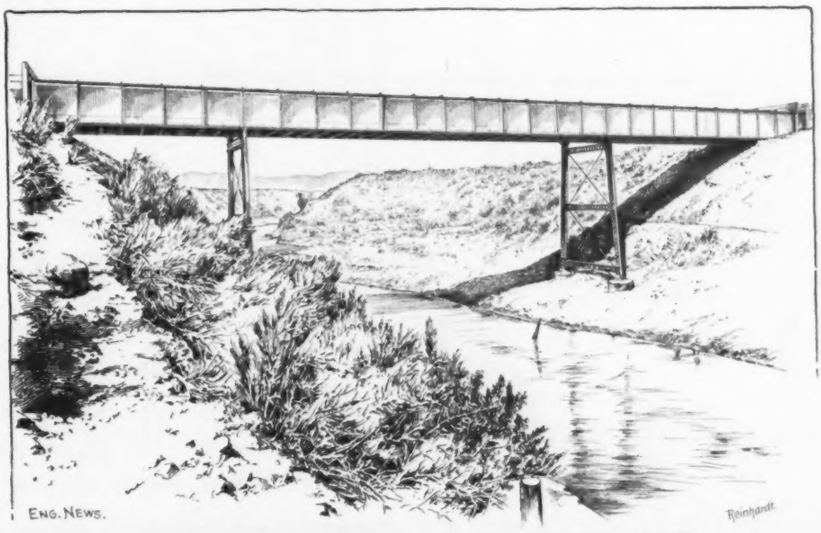


Fig. 18. INVERTED SIPHON FOR PASSING OLD CANAL BENEATH CORINNE CANAL.



Fg. 19. 130-FT. PLATE GIRDER FLUME OVER MALAD RIVER.

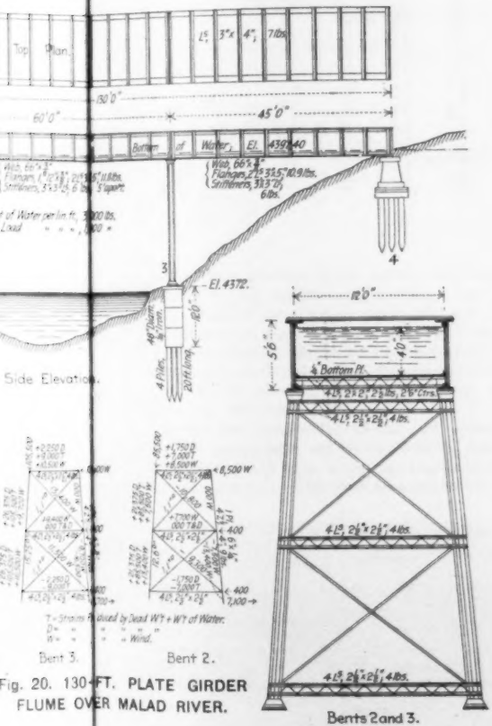
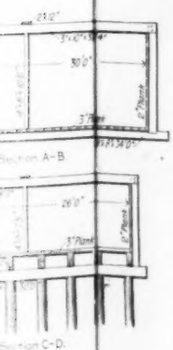


Fig. 20. 130-FT. PLATE GIRDER FLUME OVER MALAD RIVER.

Fig 14. IRON BRIDGE CARRYING WOODEN FLUME AT UPPER CROSSING OF MALAD RIVER.



THE BEAR RIVER
IRRIGATION SYSTEM,
UTAH.

Fg. 16. LOWER SIDE OF DROP ON CORINNE CANAL.

on the grade of 1.056 ft. is maintained. As the line has by that time began to climb up to the foot hill and run into rock, without any adequate compensation in the additional narrow strip of land thus covered, three drops of 7 ft. each are here put in 400 ft. apart, thus bringing the line down to the foot of the slopes again. Here a large lateral is to be taken out to run south and water a large tract of land between the Malad River and Salt Creek. For 9¼ miles further on the main canal has a fall of 2.11 ft. per mile, the size being gradually reduced to 14 ft. with 4 ft. of water. The line on this portion keeps well to the north side of the valley and heads the Walker Valley, where the company has a large well cultivated farm, under the canal. At the end of this portion, about 27 miles from the head, work was suspended in 1891, to be taken up and pushed some 4 miles farther in 1894. The grade for this portion is 2.64 ft. per mile, the width 14 to 12 ft., and the depth of water 4 to 3 ft.

In less than three miles the line on this section has climbed too far into the foot-hills again, and a drop of 39 ft. is made here, water coming down the hillside to a lower level through an open rock cut made on the incline. Near the end are two more wooden drops and one masonry drop with total fall of 20 ft. more. The canal at the end has a 12-ft. bottom and carries 3 ft. of water. There are altogether over 2,000 ft. of flumes on the West Canal.

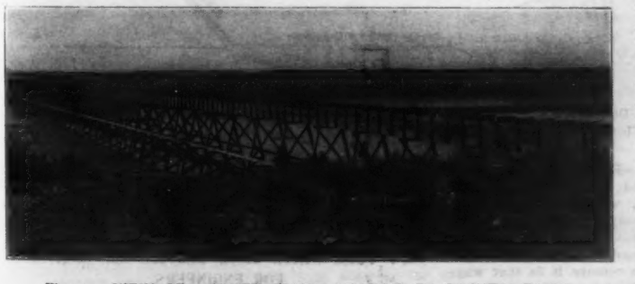


Fig. 22.—VIEW OF 1,800-FT. FLUME LEADING TO ROCHE'S FARM.

Corinne Canal.

The Corinne Canal at the head is 22 ft. wide on the bottom with banks 6 ft. wide on the top, a 6-ft. berme, and designed to carry 4 ft. of water. The grade used is 2.11 ft. per mile for the first 18 miles to just across the Central Pacific Ry., where it splits into two equal 8-ft. laterals. The fall of the country for the first 10 or 12 miles is pretty rapid, being 15 to 20 ft. per mile some of the way. There are 13 drops along this portion, with a total drop of 87 ft., one drop each of 12, 10 and 8 ft., and the rest of 5 and 6 ft. Fig. 16 is a view and Fig. 17 are details of the 10-ft. drop, and it is of the same type as most of the other drops. The drop illustrated is about 2½ miles from the head of the canal. These structures for drops are generally 48 to 64 ft. long over all.

This canal crosses other canals at several points in its course, and the waters of the other canals are passed under the main canal by so-called inverted syphons. Fig. 18 shows one of these under passages, the type being exactly the same for the others.

At 14½ miles from the head, Malad River is crossed from east to west by an iron aqueduct 130 ft. long, shown by Figs. 19 and 20, with a wooden approach of 56 ft. at each end. The aqueduct has three spans of 25, 60 and 45 ft., and is of plate girders 5½ ft. deep, the girders serving as sides of the flume. The floor for the water is of ¼-in. plate laid on latticed girder floor beams, spaced 2½ ft. and resting on inside bottom flanges of main girders. The waterway is 12 × 4 ft. The two pairs of piers are of tubular steel filled with concrete and support 25-ft. column bents. The abutments are of masonry, founded on piles. The greatest height above the river bed is 35 ft. The central or 60-ft. span has a dead load of 1,000 lbs. per lin. ft., and the live load per foot (weight of water when full) is 3,000 lbs. There were 93,000 lbs. of iron and steel; 50 cu. yds. of concrete and masonry; 1,040 lin. ft. of piles; and 2,000 ft. of grillage used in the structure. The approaches contain about 15,000 ft. of lumber. The canal width has been gradually reduced until it is 12 ft. here, and it keeps this width to the division just beyond the railway. The two sets of gates at this point have two gates each, each gate being 3½ ft. wide by 4 ft. high. The gates are shown in Fig. 21, and are very good models for other gates of similar size. The main lateral is extended on the south for six miles to the marshes along Great Salt Lake; the other or Corinne lateral, runs east along the railway to Corinne City. The two laterals are of the same type and dimensions at their head. Following are sizes of Corinne lateral between certain station numbers:

Station.	Width, ft.	Height of bank, ft.	Width of bank, ft.	Berme, ft.
0-44	8	4	4	0
44-105	6	4	4	2
105-153	4	3	3	4

Slope of cuts is 2 to 1; of banks, 2 to 1 on inside, and 1½ to 1 on outside; fall is 2.64 ft. per mile.

At Sta. 44 of this lateral another one is taken out and runs south to Roche's farm, some three miles from Corinne City. To reach this a long swale had to be crossed, requiring a flume 1,800 ft. long, shown in Fig. 22. The flume has a clear waterway of 48 × 22 ins., and a fall of 0.2 ft. per 100 ft. It is supported on timber bents spaced 14 ft. For about 400 ft. the bents are 18 ft. high between sill and cap; for most of the remaining distance their height is 10 ft. Nearly 8',000 ft. of timber was used in this flume, and the total cost was nearly $3,000. Very little trouble has been had with any of the wooden structures of this system. Especial care was taken with head-gates, drops and approaches to flume to thoroughly tamp earth in back-filling, ordinary dirt being used and tamped dry. Over 1,500,000 ft. B. M. of Oregon pine was used on the West Side system.

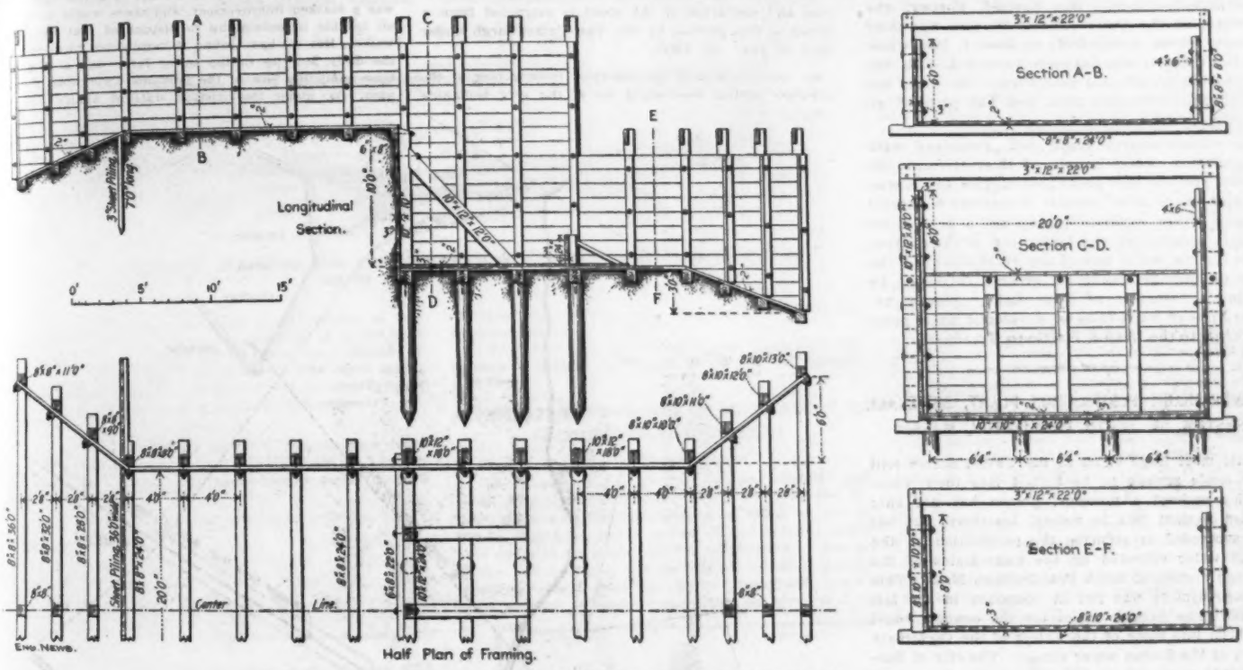


Fig. 17.—DETAIL OF 10-FT. DROP ON CORINNE CANAL.

There are 65 miles of canals and main laterals on the west side. Where crossed by roads the company has put in substantial bridges. The Bear River is practically the only source of supply for possible irrigation, as the waters of the Malad are so strongly mineral that they kill vegetation. A ditch from this and one from Salt Creek are used to carry water to Corinne to supply power for a flouring mill, a fall of 16 ft. being secured there, down the side of an arroyo.

All the irrigation works of the company have been built in the most substantial manner, in sharp contrast to most of such works in this country.

With an admirable and sure natural water supply and no conflicting appropriations of the same, this system is exceptionally well fitted for insuring a full supply of water during the irrigation season. About 80,000 acres are covered by, and will ultimately be watered from the West Canal, of which the company owns, or controls, about 50,000. Water rights are sold at $12.50 per acre, on the basis of a duty of 80 acres to 1 cu. ft. flow of water per sec., and an annual charge for maintenance of $1 per acre is made. The East Canal will, possibly, be taken hold of and extended and completed in 1896. As the Valley is traversed by two railways leading to Ogden, near by and a railroad center, it seems probable that this will become a highly productive and well settled region.

The financial affairs of the company were for a good while embarrassed, with the properties remaining comparatively idle, but lately the company has been reorganized, and the development and settlement of the lands under the canal begun in earnest.

The name of the new company is the Bear River Land, Irrigation & Ogden Water-Works Co. Mr. W. H. Rowe, of Salt Lake City, is president and general manager, and the local headquarters are at at Corinne, the general offices being at Ogden. There have been several engineers in charge at different times. Mr. Samuel Fortier, the engineer for the Ogden Water-Works, was chief engineer, from April, 1891, to Jan. 1, 1893, while Mr. Jos. Gilbert, who has been connected with the engineering department nearly from the first, has held that position since then, and has planned all the recent works.

The comparatively rapid fall, combined with the enormous water supply of Bear River, in the canyon, produce here great possibilities in the way of water power development. Water can be carried through either canal or piping, and a head of 100 to 120 ft. secured at the lower end of the canyon, while the low water flow of the river (shown in the table of gagings) could be greatly increased by making a reservoir of Bear Lake. Almost unlimited power could thus be developed at a point very close to the Utah & Northern Ry.

UNDERDRAINAGE PURIFICATION PLANT, SEWERAGE SYSTEM OF SOUTH FRAMINGTON, MASS.

While most large cities of the United States still allow crude sewage to be turned into their water supplies without a murmur, Boston has not only guarded against this in several instances, but has even succeeded in securing the purification of the subsoil water collected by the underdrains of the sewerage system of South Framingham, Mass. This sewerage system was put in operation in the fall of 1889. The natural outlet for the sewage would have been into some of the waters of the Cochituate system of the Boston water supply. The city of Boston offered to contribute $25,000 towards the cost of diverting the sewage from the above drainage area and purifying it, but finally refused to do this, owing to the fact that the underdrains discharged into Beaver Dam Brook, a stream in the Cochituate watershed. In the year 1894 an arrangement was made to the effect that the town of Farmingham, in which the village of South Framingham is located, would either divert the underdrainage from the watershed or purify it, Boston agreeing to pay Framingham the original $25,000 and $6,000 in addition. In the middle of November, 1895, the plant designed to carry out this agreement was put in operation. Its character is indicated by the general plan, Fig. 1, which shows the sewage pumping station and force main; the old underdrain and its point of discharge; the reservoir to which the underdrainage is now diverted and the alternate pipe line to the old sewage reservoir; the location of the new pumps in the sewage pumping station; the suction pipe and force main, and the filtration area for purifying the underdrainage.

The plant in question was constructed by Mr. J. J. Van Valkenburgh, of South Framingham, Mass., as engineer, to whom we are indebted for the information concerning it which is here given. Mr. Van Valkenburgh, it may be mentioned, was constructing engineer of the original sewerage system.

A section of the reservoir is shown by Fig. 2, and a view of it, drawn from a photograph, by Fig. 3. The side walls are of field stone laid in cement mortar. The other details of construction are shown by the illustrations. The reservoir has a capacity of about 335,000 gallons. The bottom of the reservoir is about 25 ft. below the surface of the filter bed.

The town now owns about 22 acres of land at and near the pumping station. The filter bed for the underdrainage has an area of 36,500 sq. ft. It was constructed on a side hill. Wood and brush was first cleared off, then the land was grubbed and the top soil and loam removed to an underlying stratum of sand. The embankments shown in Fig. 1 are generally 4 ft. high and 4 ft. wide on top.

Two 500,000-gallon Knowles pumps have been provided for lifting the underdrainage to the new filter bed. These are operated from the boiler plant of the sewage pumping station in which they are located, and without extra attendants. It is expected that during the greater part of the year it will not be necessary to operate these pumps, the underdrainage being diverted to the sewage reservoir and pumped with the sewage to the filtration or irrigation area, put in operation in 1889. When the volume of underdrainage is large it will be pumped to the special beds provided for it.

All the new work has been done by day labor without a contractor. The cost is given as $19,000.

The following information regarding the construction and operation of the plant is extracted from a letter to this journal by Mr. Van Valkenburgh under date of Dec. 18, 1895:

My experience with the reservoir construction of the sewerage system determined me at the very beginning

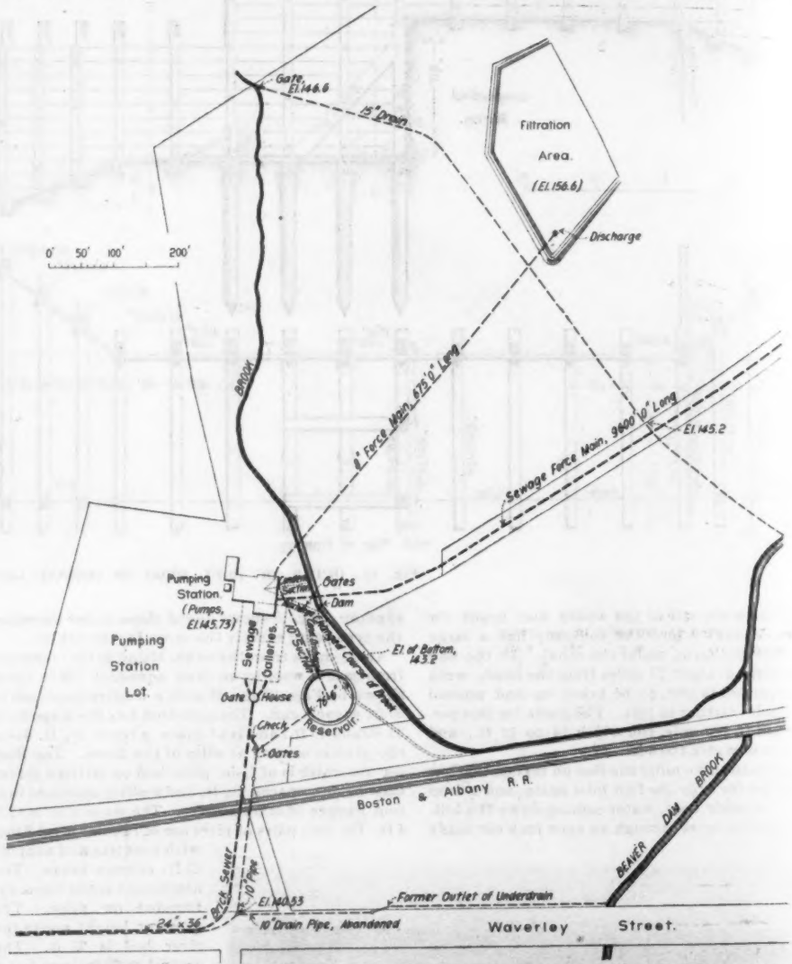


Fig. 1.—GENERAL PLAN OF WORKS FOR THE PURIFICATION OF THE UNDERDRAINAGE OF THE SEWERAGE SYSTEM OF SOUTH FRAMINGHAM, MASS. J. J. Van Valkenburgh, Engineer.

(of work on the new reservoir.—Ed.) to drive two lines of sheet piling 5 ft. apart, and extending about 4 ft. below the bottom of the wall, which was accordingly done. The earth was then excavated and wall built. During the progress of this work the interior of the reservoir was being excavated and removed in barrows, until it became impracticable to remove it in that way, when a steam derrick was set up, the material thrown into scales and discharged into carts

We encountered considerable water, but by keeping the pumps going day and night we were not seriously embarrassed by it.

Our greatest trouble occurred when, within 3 ft. of grade for excavation, a large boulder was disclosed. It had several large fissures in it, from which water poured in considerable quantities. I did not dare allow much blasting for fear of injuring the wall or enlarging the fissures and thereby causing the water question to become more serious. The consequence was the greater part of the top of this boulder, 25x15 ft. and 3 ft. deep, had to be wedged off.

At the time the reservoir had to be put in use, the weather was so severe that the wall was not plastered. This will be done in the spring.

I will speak of one other feature that may throw some light on a possible future investigation of the filtration end of the system. The small brook that runs near the station has periods of overflow that nearly flood the station. Therefore, previous to commencing the construction of the reservoir, we intercepted this brook as shown on large plan, by a 15-in. drain (joints wrapped with straw) extending withing 70 ft. of the filtration area, and at an elevation 10 ft. below said area. This drain not only relieves our station of again being flooded, but it will be the life of the filtration area.

For nearly two weeks the filtration area received 100,000 gallons of underdrainage per day, and although at first it naturally worked slowly, in a few days there was a marked improvement, and there would have been no trouble in continuing to dispose of that amount of water. But we have found it more economical to pump the daily flow up to the sewer farm, and at the same time pump the flow of the previous night upon the new area. So, under the existing state of affairs, the new area receives about 140,000 gallons per day. This underdrain is very susceptible to wet and dry weather, so there should be no surprise if in future reports the amounts vary considerably.

NEW YORK STATE CIVIL SERVICE EXAMINATIONS FOR ENGINEERS.

As a matter of general interest to young engineers, we republish the following set of questions used in the civil service examination of Jan. 25, 1896, for the positions of assistant engineer and leveller in the service of the State Engineer of New York. The successful candidates in this case were to be chiefly appointed on canal work. Candidates were required to show the work of computation in all cases. Books of tables were furnished by the examiners for the candidate's use.

QUESTIONS FOR ASSISTANT ENGINEER.

Form C.

1. Write a concise specification for first-class coursed ashlar masonry with proper backing.

2. State how foundations should be made under heavy masonry with regard to different kinds of soil.

2. Write a specification for a pile foundation.

4. If masonry is to be founded on rock write what methods should be adopted to secure the best results?

5. Write a concise specification for the construction of a water bearing embankment.

6. Given the elevation at a point and incline transverse profile under it, write out the field notes for setting out the slope stakes of a bank, 10 ft. wide at the top, 15 ft. high at the center of the bank, and with slopes 1½ to 1.

7. How would you determine the amount of flow of water in small and in large streams?

8. How would you proceed to determine the amount of water that a given watershed may supply?

9. If the water were drawn from a canal and it was required to determine its existing physical condition and to ascertain the quantities of excavation, of embankment, of slope wall, etc., required in a proposed enlargement, what surveys, sections, etc., should be made and how would you proceed with such work; what instruments and apparatus would be needed; what would be the various steps up to the full estimate?

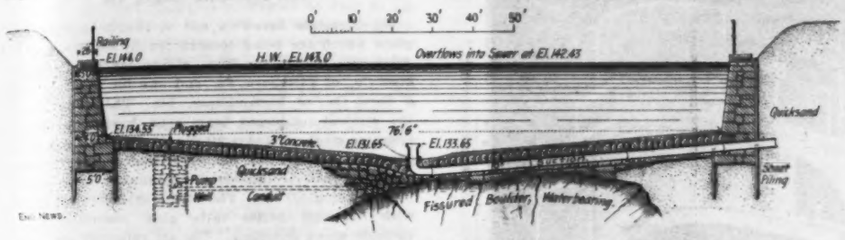
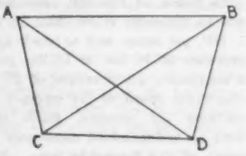


Fig. 2.—RECEIVING RESERVOIR FOR THE UNDERDRAINAGE OF THE SEWERAGE SYSTEM OF SOUTH FRAMINGHAM, MASS.

Form B.

1. In order to find the distance between two inaccessible objects, C. D., a level distance, AB, of 1,000 ft., was measured and the following angles at A, B, read with equal care:



BAD=	40°	10′	20″
BAC=	82°	25′	20″
DAC=	42°	15′	30″
DBC=	34°	04′	10″
CBA=	35°	12′	30″
ABD=	290°	43′	05″

What is the best attainable value of the distance CD?

2. A Warren girder composed of equilateral triangles is 10 ft. deep and 80 ft. long. It has 8 equal panels in the lower chord and carries a load of 5,000 lbs. at each lower apex. Find the stresses in the pieces.

3. What is the horse-power that a water fall 120 ft. high and 100 ft. wide may supply, when it delivers 18 cu. ft. of water per second for every foot of its width?

4. The jib of a crane is 10 ft. long. The tie rod is horizontal and is 8 ft. long. Find the pull in the tie rod when the crane supports a weight of 1,500 lbs.

5. A rectangular masonry wall 10 ft. high and 6 ft. thick, acts as a dam to water whose surface is level with its top. Find the moment of the water pressure, per foot of length of wall about a point in its foot, 9 in. from its front face, and find the moment of stability, about the same point. Assume a proper weight for masonry and give answers in foot pounds.

QUESTIONS FOR LEVELLER.

Form B.

1. A stick of timber is 36 ft. long, 15 in. thick, 9 in. wide at one end and 1 ft. wide at the other end. How many feet board measure are there in it?

2. The sides of a triangle are 50, 60, 100 ft.; find the value of the greatest angle.

3. Find by means of logarithms the value of x in the equation $160x=430$.

4. Describe how to lay out a 3° curve to the right from a P. C. at Station 118+36, the angle of intersection being 10°. Use the method of deflection angles and also 50 ft. sub-chords.

5. Explain clearly why the radius of a 1° curve is taken to be equal to 5,730 ft.

6. Write a form of level note book showing the cuts necessary to lay a pipe having a grade of 0.60 per 100, the cut at station zero being 20 ft. Assume 6 stations 25 ft. apart, the pipe rising from station zero. Also give the numerical checks on the levels as the work proceeds.

7. Given a canal trench of 36 ft. bottom width, slopes 1½ to 1, center heights 26 ft., with the transverse slope at one end of 8 to 1, and level at the other. Find by the prismoidal formula, the volume contained between parallel ends 160 ft. apart.

Form C.

1. What is hydraulic cement? How many kinds do you know of and what are they?

2. How would you test cements? Give your views as to the strength they should develop after different periods of time, without admixture of sand and also with certain proportions of sand.

3. About what are the proper proportions of cement and sand in mortar, and of cement, sand and stone in concrete? How should these be manipulated?

4. What are coffer dams and how are they constructed?

5. Describe a good quality of brick and state how you would know a good brick from a bad one.

6. What are headers and stretchers, and what percentage of a wall ought they respectively to bear?

7. What are the principal conventional signs used in mapping a topographical survey and what relation shold the scale bear to the area mapped?

8. How would you conduct the field work of a survey to determine the area and topography of ground of irregular boundaries where a reservoir is to be located?

9. How would you lay out a true north and south line by observations on Polaris?

10. Show how you would extend and measure a line through a barrier obstructing vision, as, for example, a building.

A PROPOSED IMPROVEMENT IN ARRANGEMENT OF SERVICE OF NIGHT WATCHMEN.*

By C. F. Simonson.

I have been led to give considerable thought and study of late to improvement in the watch service for large buildings, mills and factories in which we are so largely interested, owing to the many instances which have come to my notice of the unsatisfactory class of service now in vogue, and the number of fires resulting therefrom, and I deem the matter of sufficient importance to bring it before you to-night in hopes that by united effort we may institute a reform which will not only prove of great benefit to the interests we serve but to those poor fellows who have to work while the rest of the world sleeps—the night watchmen. From my earliest field experience and inspection of special hazards I have noticed the distrust which manufacturers and other employers have for night watchmen, many preferring to leave their buildings wholly unprotected rather than to employ a man to watch at night; and others are only induced to employ such a person by the almost unanimous demand made upon them by the insurance companies and allowance made therefor of from 25 to 50 cts. in all rating schedules.

I would like to offer what I consider a solution of this problem, and a plan of employing two watchmen at the expense of one. This, if adopted, would, I believe, remedy to a large extent the defects found in the present system, and considerably raise the standard of efficiency of the average night watchman.

First let us inquire: Why is it that watchmen are so universally mistrusted? They leave their homes at 5 or 5.30 and reach the factory at 6 o'clock. After looking over the plant and seeing that everything is safe and in order, they commence their rounds at 7 o'clock, and make half-hourly or hourly trips until midnight, when they eat their lunch. They then continue the rounds until 6 o'clock in the morning, when they start the fires under the boilers and get everything ready for the day's work, and are relieved by the engineer at 7 o'clock. When we consider that this work of 14 hours is done at night, when the city is at rest and the quiet is only relieved by the sound of his own heavy dragging footsteps on the floors, through dreary and gloomy rooms, poorly ventilated and dimly lighted by his solitary lantern, every night in the year, through cold, chilly rooms in winter and hot, stuffy nights in summer, when it is natural for all of us to desire rest and sleep, is it any wonder that the watchman is found inefficient, careless and even criminal in his disregard for the interests of those by whom he is employed.

He goes home to breakfast and tries to sleep. The bustle and noise of the city is upon him; the noise of wagons in the street, of children playing, dogs barking and household duties performed by other members of the family, all disturb his rest, and he rises in the afternoon ill prepared for his monotonous night labor. He goes to work with a heavy heart, with no courage or strength to support him; he tries to catch a few minutes' sleep between rounds, and is only startled from it by the sound of heavy blows on the door, made by a policeman or runner from the Central District Watch Office, where it has been discovered that he has missed his call, or he mechanically does the work wholly unconscious of what he is doing, he walks in his sleep and fails to discover the fire in its incipiency, and is frequently found in the ruins the next morning.

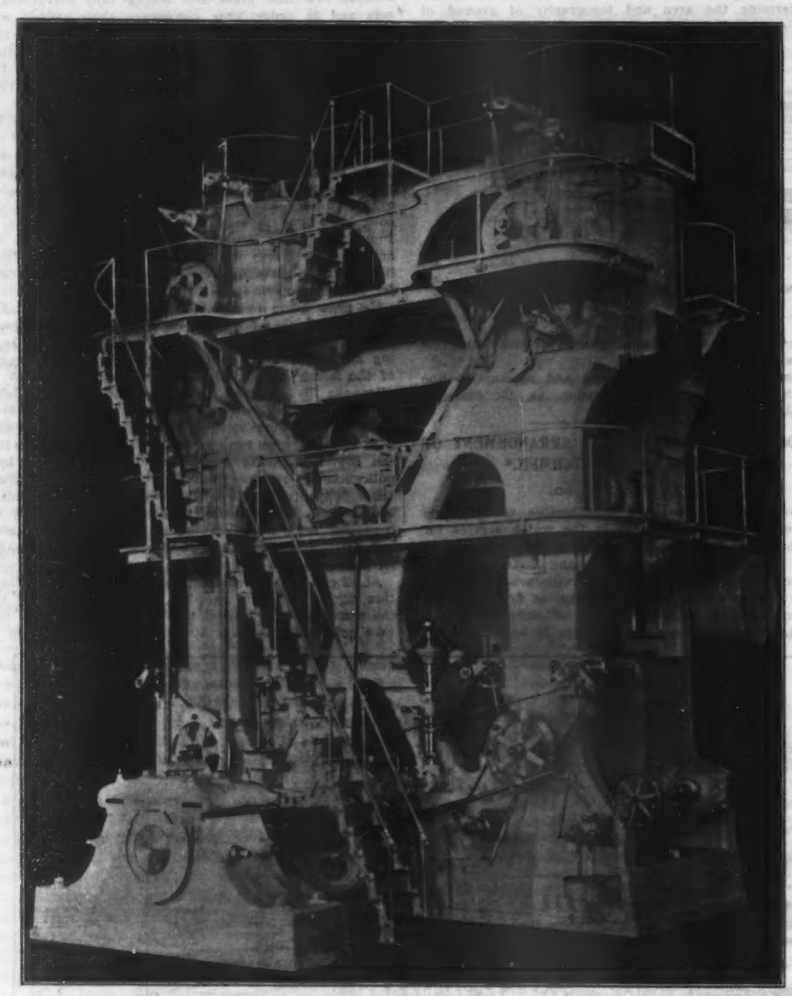
At the Phelps, Dodge & Palmer shoe factory fire in this city a few years ago, the watch-clock showed that the watchman had passed through the floor a few minutes before the fire was discovered by some one in the street who gave the alarm, and the watchman had no knowledge of it until the arrival of the engines. This fire cost the insurance companies over $20,000, and could undoubtedly have been prevented if the watchman had been alive to his duty, as it must have been smouldering and burning when he passed through the room. The old red planing-mill on the river burned some years ago and the remains of the watchman, his dog, lantern and watch-clock were found together in the center of the mill, showing that he evidently went to sleep and something overturned the lantern, setting the shavings on fire and burning the mill.

At a recent fire in the machine shop of McCormick's harvester works, Chicago, the watch-clock showed the

Fig. 3.—VIEW OF NEARLY COMPLETED RECEIVING RESERVOIR FOR THE UNDERDRAINAGE OF SOUTH FRAMINGHAM, MASS.

*From an address delivered at a meeting of officers and special agents of the Hartford Fire Insurance Company. The author is General Inspector of the company.

watchman had been through the shop five minutes before the fire was discovered by others and had failed to notice it. Mr. F. Herold, of the Herold & Sons' furniture factory in this city, admits that his watchman sleeps at night, but says he will make no change because they all do it, and he has tried several. His watchman has a habit of waking at the proper time to push the button but has frequently been found asleep. Some watchmen sleep between rounds, employing alarm clocks and dogs to wake them at the proper time. One ingenious fellow constructed a bench on which he would seat himself astride, so that if he went asleep he would fall over and be wakened to make his rounds.



BLAST-FURNACE BLOWING ENGINE WITH REYNOLDS-CORLISS VALVE GEAR.
Built by the Edward P. Allis Co., Milwaukee, Wis., for the Carnegie Steel Co., Pittsburg, Pa.
Weight, 600,000 lbs. Height, 33½ ft.

Superintendent Shepard of the Fire Patrol says that they frequently find watchmen asleep at the stock-yards during the fifteen minutes' relay time at midnight, particularly on hot summer nights. At a large packing-house in the stock-yards it was discovered that the watchman left the heavy fire doors open between the chill-room divisions, and upon being followed he was discovered asleep, lantern in hand, leaning against the door-casing nearest his box, which he had failed to pull. At the United States warehouse a short time ago the watchman slept and missed his call. Awakening and finding that he had overslept, he went to the basement, spilled the oil on the floor, set it on fire and turned in the alarm. He showed a burned coat to prove his statement that he had been occupied in extinguishing the fire, which did not save him, however, after an investigation, and he was discharged. They will tamper with watch-clocks and with the key clocks; it is easy to have a key made containing all the notches so that they can make the records at one time and sleep the balance of the night. With electric clocks they have been known to destroy the insulation and effective working of the apparatus for the time being.

At the recent fire in the Chicago Forge & Bolt Co. works, the watchman had hard work to get out of the building alive, and Chief Sweenie tells me the firemen frequently have to take the watchmen off the fire-escapes. It is evident from the above that watchmen are of little benefit in a building at night, and that even the most perfect watch service will not compel a man to stay awake when nature demands sleep.

It is cruel and inhuman for us to exact such a service from any man, and in my opinion earnest effort should be made to lighten their burden by advocating the following plan: Select two men capable and fit to be watchmen, sweepers or helpers; let one begin his shop work at noon; when the factory closes at night he takes a round until satisfied that everything is all right and in proper shape, then eats his supper, which he carries with him, and enters into his regular rounds of watching. He watches until 11.30, reaching home before midnight. The second man relieves him at that time and watches until 6 a. m., when he eats his breakfast, starts the fire and opens the factory for employes at 7. Having had breakfast and the factory open, he is ready to go to his shop work until noon, when he goes home and returns at 11:30 that night. In this way the expense would be no greater than employing a sweeper or helper during the day and a watchman at night, and each would have one-half day and one-half night at home. It is plain to any one that a man with these hours at home could get the requisite amount of sleep. Change about could be had each week, so that the man who had the first half of the night to watch one week could have the sond half the next week and vice versa.

A man that works nights and sleeps days becomese a machine instead of a live man, and it is a common thing to find buildings badly on fire with the watchman taken out suffocated and nearly dead, and in all the big fires in Chicago at night watchmen have been employed. In the Pinkerton watch service the men go on at 7 p.m. and come off at 10; go on at 1 a. m. and off at 5. In the watch-tower fire service, from which an average of 400 alarms are sent out each year, the men are relieved every two hours, so careful are they that they must not sleep. This system has been tried for the past two years by Charles F. Elms Engineering Works and Lyon & Healy Organ factory of this city, who recommend it highly and say that nothing could induce them to change back to the old system. No man can work continuously 24 hours at night and have ten hours at home during the day for eating and sleeping, and be fit for work of any kind, much less that of watching and guarding millions upon millions of property values in which it may be the safety of cities is involved, and I earnestly recommend that this system of watching be proposed and its adoption secured wherever possible.

ALLIS VERTICAL COMPOUND BLOWING ENGINE FOR THE CARNEGIE STEEL CO.

We illustrate herewith one of twelve blowing engines which are being constructed by the Edward P. Allis Co., Milwaukee Wis., eleven for the Carnegie Steel Co., of Pittsburg, Pa., and one for the Sloss Iron & Steel Co., of Birmingham, Ala. The engine is of the vertical compound beam type, having one high pressure steam cylinder 40 ins. in diameter, one low pressure cylinder 78 ins. in diameter and two air cylinders each 76 ins. in diameter, the stoke of all pistons being 60 ins. The steam cylinders are fitted with Reynolds-Corliss valve gear, controlled by a variable speed governor. The air cylinders are fitted with rolling inlet valves of the Corliss type, and pressed-steel poppet valves are employed on the discharge. The inlet valves are actuated positively by means of an eccentric and the proper connections, while the delivery valves open automatically and are closed positively by means of internal pistons actuated by the same gearing which drives the inlet valves. The engine complete weighs about 600,000 lbs., the flywheel weighing 100,000 lbs. This flywheel is not shown in the photograph, but goes in front of the engine just back of the pillow block which stands in the foreground. The engines are to be supplied with steam at 125 lbs. pressure, and are guaranteed not to consume more than 16 lbs. of dry steam per I. HP. per hour, and to work against an ordinary air pressure of 16 lbs. to 18 lbs. per sq. in., and against a maximum air pressure of 25 lbs. per sq. in. The maximum speed of the engines will be about 50 revolutions per minute. Each engine will be fitted with an independent condenser and steam-driven air pump of the Reynolds type. Ten of the eleven engines for the Carnegie Steel Co. are to be erected at the new furnace plant at Duquesne, Pa., the other engine for this company going to their Lucy furnaces at Pittsburg.

THE CODE OF ENGINEERING ETHICS ADOPTED BY THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

There has been a great deal said in engineering circles during the past half dozen years concerning the advisability of formulating a professional code of ethics, limiting the practice of engineering to those whose competency has been approved by some official examining body. The attempts to secure any favorable action on either of these propositions in the United States have ended in failure. In Canada, however, a different result has been reached. The Canadian Society of Civil Engineers, at its annual meeting a year ago, requested the Council of the Society to prepare a code of ethics and submit it to the members for adoption as a by-law of the Society upon a letter ballot.

The total number of ballots cast was 131, and the proposed code was adopted by considerably more than a two-thirds majority, and is now a by-law of the Society. At the annual meeting held last month, the committee on "Professional Status" made a report advising that the Council secure charters for the Society from the Local and Provincial Legislatures. These charters, we presume, are designed to give the Society similar powers in the control of professional work to those possessed by the Canadian Surveyors' Associations.

We reprint the code of ethics in full as follows:

Duty of the Engineer to His Client.

1.—Every member of the Society should perform the work he undertakes to do to the best of his ability and in the true spirit of his engagement, feeling it to be his duty to present all ascertained facts in their true light.

The Client's Obligation to the Adviser.

2.—The Civil Engineer has a right to expect from his client the same consideration and deference to his opinion as is by their clients accorded to the members of other professions—Law and Medicine for example and

without which the adviser should decline to advise. The surest way for the engineer to obtain such necessary consideration and deference from the public will be found in his manner of carrying himself.

Mutual Relations of Chief and Assistant.

4.—The Assistant Engineer must loyally obey and support his Chief, to whom it will be his duty to report directly on all matters relating to the work on which they may be jointly engaged. His report should be full and explicit on all important points and exact to the best of the Assistant's knowledge and belief, cloaking nothing, even though going to show that previous reports had been inaccurate or not duly weighed in some particulars affecting the well-being of the business in hand.

4. The Assistant Engineer is entitled to look to his Chief for, and to receive from him, advice for his guidance in the proper performance of his duties and, where right, to expect his support in matters in dispute between him (the Assistant) and his subordinates or between him and the contractors working under him. He is also entitled to the aid of the Chief Engineer's professional experience or counsel where unlooked for or extraordinary difficulties present themselves or changes of original plan may be called for in the work on which they are associated, so that responsibility may be fairly apportioned between them.

5. It is the duty of both Chief and Assistant, each in his department, to study proper economy in the doing of the work, the management of which they have undertaken, and in every way consistent with the maintaining of the good character of the work, to make the client's interest the guiding object.

6. The Engineer may legitimately suggest experiments, with a view to improvement, whether in methods of doing the work which he oversees or for raising its character, but such experiments should only be undertaken with the full consent and co-operation of the party, whether client or contractor, on whom the expense may fall, and on the understanding that to them will accrue all pecuniary benefit from the success of the experiment.

7. It shall be considered unprofessional for any member of this Society to seek the position of an expert to report on any work that is in charge of a recognized Engineer.

8. It shall be the duty of any Engineer before examining any work with a view to report thereon to give the Engineer due notice before going on with the investigation, in order that he may have every facility to explain and sustain his methods of carrying on the work in question.

Professional Services of Engineers to Each Other.

9.—Interchange of professional assistance between members, as tending to promote fraternal intercourse and mutual good-will, is not to be discouraged, but neither is it to be considered obligatory on a member to respond to the request of a fellow-member for professional counsel or assistance. Service so rendered must be entirely voluntary on the part of the member whose aid is sought.

Pecuniary Matters, Advertising, Etc.

10.—The Civil Engineer may consistently with professional status take out patents for new inventions or for improvements on old ones, and may sell or otherwise dispose of the patents for his own advantage. He may undertake surveys and the engineering of works by contract, or he may take contracts for the construction of works on a percentage of their cost. Advertising with a view to attracting business should, where resorted to, be as far as possible free from egotistic or self-laudatory references and expressed in language not derogatory to the dignity of the profession.

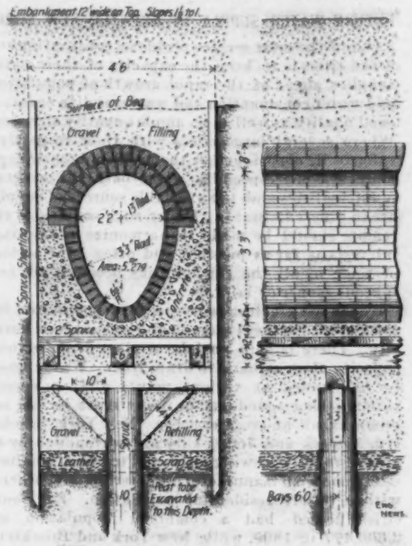
Duties of the Engineer to the Public.

11.—The Civil Engineer whose advice is sought in respect to the usefulness, practicability and cost of a work should, before expressing his opinion, obtain reliable information on all points involved in the matter submitted to his judgment, including the probable paying capacity of the contemplated undertaking. He must be cautious how he recommends large preliminary outlay; should avoid connecting himself with schemes or projects of merely speculative character, always bearing in mind that his professional reputation will be to a great extent judged by the inherent merits and commercial value of the undertakings with which his name may come to be associated.

THE DISLOCATION OF A BRICK SEWER IN SOFT GROUND AT LYNN, MASS.

Reports regarding the settlement and crowding to one side of a 26x39-in. sewer built in unstable material at Lynn, Mass., prompted us to write to Mr. Chas. W. Gay, City Engineer, for the facts in the case. Mr. Gay has kindly sent us a partial longitudinal and a cross-section of the sewer, which are reproduced herewith, and a general description of the sewer and its dislocation. The letter was dated Nov. 30, 1895, and, omitting prefatory remarks, is as follows:

This sewer was built upon the location of a proposed street forming the westerly boundary of Glenmere Park—in former times known as "Bog Meadow." This is a large area unfit for habitation, therefore condemned by the city, whose Park Commissioners will some time convert it into a public ground. This entire area is very peculiar in its underlying formation, being in many places a veritable quagmire. The street referred to is to be 50 ft. wide. The sewer lies on the middle line thereof Had there not been fear of evil effect of unbalanced side pressure ensuing street building, it would have been placed to one side for convenience of prospective occupants of land on that side. The sewer lies at a distance



Sewer in Soft Ground at Lynn, Mass.
Chas. W. Gay, City Engineer.

varying from 60 to 25 ft. from the solid ground bordering the bog—at the point under discussion being about 30 ft. Where street filling has been done under my direction it has been equally distributed along the sides of the sewer. At the point of dislocation additional filling has been done without my knowledge. There, in a distance of 125 ft. the sewer has been crowded over about 4 ft. and depressed about 3 ft., these figures giving maximum disturbance. Here is one of the mud pockets, into which the refuse of a large soap factory is discharged, and here upon an area about 50x25 ft., lying on the side toward solid ground, has been done the filling which I assert to be the cause of the damage. My first information was that about 200 loads of gravel and rock had been dumped there and sunk from sight. Later, I have been told that there were nearer 400 loads. It is not claimed by anybody that much was dumped on the opposite or softer side.

I propose now to fill on the softer side until there is no uplifting of the adjacent surface of the bog; afterward to fill equally on both sides until there shall be no subsidence of material. This may result either in righting the substructure or providing a stable foundation upon which to rebuild next year. Meanwhile the sewer is working all right as an inverted syphon.

The piles shown in the illustration are everywhere 6 ft. c. to c. At the section under discussion they are driven from 36 to 38 ft. below the caps, being spliced in some cases. In a nearby section where they were driven 100 ft and more, not a particle of movement is discernible.

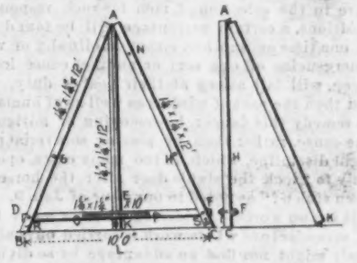
A FARMER'S LEVEL AND DRAIN-GRADING INSTRUMENT.

In the proceedings of the Association of Ontario Land Surveyors, for 1895, Mr. Allan Ross Davis describes a simple instrument devised by him for the use of farmers in ditch-work. It is simple, cheap and light, cannot get out of adjustment and does fairly accurate work.

This "level" is made as follows: Two white pine legs, $1\frac{1}{4}$ in. square and 12 ft. long, are hinged together on the inner side, and a third similar leg is hooked on above so as to form a brace. To the bottom of the two hinged legs is bolted, 1 ft. from the lower end, a strip $1\frac{1}{4}$ in. square and 10 ft. long. In the two legs and at a convenient height for the eye, say $4\frac{1}{2}$ ft. from the bottom, two corks are inserted in holes bored at G H, equally distant from the bottom. In these corks fine steel needles are inserted, to be used as sights at equal distances from the hinge. A plumb-line is suspended from a hook in the hinge rivet, and the brace-leg has a sharp 2-in. point to enable it to better hold in the ground.

On the center of the horizontal arm is screwed a brass graduated scale, and the original adjustment is made by seeing that the plumb-line cuts the center of this scale in the first and reversed positions of the tripod on a level floor. In operating this level the brace-leg is moved until the line just swings clear of the scale and one of the two other legs is raised or lowered until the line strikes the scale-center. Sights are taken over the needles to a pencil held against a piece of white paper on a rod. When the difference in level between the two extremities of a proposed drain is found, the grade in inches per 100 ft. may be established. To run the required grade with the level the brass scale has first been graduated by raising one leg 1-10 in. at a time, revolving the whole tripod on the other leg and marking, for each 1-10 in., the point cut by the plumb-line on the scale. As the distance B C is 10 ft. each graduation denotes 1 in. per 100 ft. In running any selected gradient all that is required is to raise or lower one of the legs until the line cuts the proper graduation. The cost of the device is about $3.

A device somewhat similar, but less convenient than that prepared by Mr. Davis, has been used by the Chinese for ages. What is called Brown's level differs from that of Mr. Davis in having two hinged legs with the horizontal bar placed about midway and folding into a recess in one of the legs when not in use. It is provided with the plumb-line and scale and folds up like a walking stick. It is interesting to note that the level described by Vitruvius, Roman architect and military engineer to Julius Cæsar, was practically the same in principle. As described in his "Ten Books of Architecture," this instrument, called a "Chorobate," was made of a squared piece of wood about 20 ft. long, with legs at each end, connected longitudinally by two bottom braces. Near each end of the upper piece were hung two plumb-lines, cutting marks made on the lower braces when the legs stand on a level surface. Levelling was done by making the lines again cut these marks and then sighting over the top surface. When the wind interferes with the plumb-lines, he suggests hollowing out a trough, 5 ft. long, in the top stick and filling this with water. When the water-level touches equally the ends and sides of this channel, the instrument was assumed be level.



A Farmer's Level for Laying Grades of Tile Drains.

An older, but less accurate level, described by Vitruvius, was the Dioptro. This was a T of cast metal, freely suspended by a link and two pins at the middle part of the top of the T. The vertical limb acted as a plumb-bob, and sight was taken through the link over the horizontal arm, which was exactly at right angles to the vertical. The chief objection was that this horizontal arm was too short for accurate work.

The New East River Bridge Commission practically adopts the plan of the Chief Engineer Mr. L. L. Buck, and has resolved that the bridge shall be not more than 116 ft. wide, and that it shall have upon it six tracks on a level. Two of these tracks will be for elevated railway service and four for surface railways. The footwalk will be overhead. The approaches and tracks to the bridge are to provide equally, without discrimination, for the railway passenger service in both New York and Brooklyn, and plans are ordered to be prepared accordingly. The sum of $500,000 has been voted, by the two cities equally, for the preliminary work to be done this year; and it is assumed that no contracts will be given out before July. By Jan., 1897, it is expected to make such progress that $100,000 per month must be provided by the cities interested.

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The brief paper in another column on the proposed change in the common system of employing night watchmen is, we believe, deserving of careful study and consideration, not only by everyone who employs night watchmen, but by those in charge of railway signal service, and, indeed, by everyone who employs night workmen in positions where reliance must be placed upon their faithfulness and fidelity to their trust. With the best of care in the selection of men for such responsible positions, a certain percentage will be found who at one time or another, either habitually or when emergencies of one sort or another cause loss of sleep, will fall asleep at their post of duty. Is it not then the part of wisdom as well as of humanity to remedy this danger by removing or mitigating the cause, rather than by placing sole reliance on rigid discipline, which, in too many cases, operate only to "lock the stable door after the horse has been stolen?" as noted in our issue of Jan. 9.

It is also worth considering whether many lines of manufacture where work is carried on continuously might not find an advantage by so dividing their shifts that no set of men will be obliged to work the whole night through. Of course, in an ordinary establishment, night work is only occasional, and the shifts are arranged to suit the regular operation by day.

One of our subscribers writes:

I would be glad to see discussed in the columns of Engineering News the dredging practice of this country and England. In the latter country they seem to use the continuous bucket dredge, while here it is never seen. It seems that the English method would be most expeditious, but originally the more costly. It would be interesting to see each method justified by its advocates.

We will be glad to have some of our readers who are interested in dredges and dredging practice present data upon this subject in our Correspondence column. The difference of conditions existing in this country and in England may explain to some extent why the ladder dredge is in comparatively limited use here. Its greater cost, involving a heavier charge for interest on investment and for depreciation, the great number of pieces to be kept in repair, and the greater liability to stoppage for repair due to the number of pieces, are qualities that are not likely to commend it to American contractors. In many other kinds of engineering apparatus a similar difference will be found between the practice of this country and England, the English practice apparently taking little account of first cost, while in America, with its higher rate of interest, first cost is apt to be the chief consideration. A well-known example is that of steam boilers. In England boilers other than those of the water tube type are almost entirely internally fired, involving expensive furnaces, large diameter and great thickness of shell and consequent high cost, while in this country the cheap, externally fired horizontal tubular boiler is most extensively used, a type almost unknown in England.

FUTURE WATER SUPPLY OF GREATER NEW YORK.

One of the most serious problems confronting our great cities is to keep the capacity of their water supplies ahead of the rapid growth of population and water consumption and waste, and to ensure a good quality as well as an ample quantity of water. Where several large cities with their respective suburbs lie close together the problem becomes yet more serious, especially when both the several municipalities and the available sources of supply are in different States. Under such conditions attempts should be made to harmonize conflicting interests as far as possible, and often joint action of some or all the communities becomes advantageous sooner or later.

By far the greatest aggregation of population in the United States centers in and around New York city. There is here no lake or river of unlimited capacity close at hand to draw from. Water must be impounded at various points and conveyed through long aqueducts, or resort must be had to pumping, all at great expense. New York, Brooklyn, Newark and Jersey City are surrounded by a host of rapidly growing cities and towns of smaller size, some with manufacturing interests and others with a purely residential population. The four cities named had a combined population of 2,666,477 in 1890, while New York and Brooklyn alone claim about 3,000,000 at the present time. New York city is now using about 190,000,000 gallons of water per day, and has a water supply completed and under development calculated to yield 280,000,000 gallons per day under conditions of minimum rainfall. Brooklyn used an average of about 80,000,000 gallons a day in 1895, and has a minimum available supply within its present watershed of about 115,000,000 gallons, a part of which has not yet been developed. In Newark the average daily water consumption in 1895 was about 22,000,000 gallons. The city has a contract with the East Jersey Water Company for works with a daily capacity of 50,000,000 gallons. These works have been in operation since 1892, but their capacity is now in question, as has been stated in detail in these columns within the past two weeks. As to Jersey City, the best figures available also indicate an average daily consumption of about 23,000,000 gallons. As the water now furnished is unfit for use it may be said to have no available supply. The above figures combined indicate a present daily consumption by the four cities named of 315,000,000 gallons and an available minimum daily supply, when works under way are completed, of 445,000,000 gallons.

For the present only Brooklyn and Jersey City need concern themselves regarding increased water supplies, but New York will be at the end of its 90,000,000-gallon surplus before many years, and by 1920 Newark will at least be considering its next move, if it has not already taken it. Brooklyn, as set forth in the abstracts of the reports of Messrs. Worthen, De Varona and White, printed elsewhere in this issue, is now figuring on an additional daily supply of 100,000,000 gallons, which it calculates will be sufficient for its needs until 1922 or 1923. Jersey City has long been trying to get a new supply of 50,000,000 gallons a day, but present indications are that this would not be sufficient longer than until about 1920.

In the life of municipalities 20 or 30 years is a very short time. It appears from the above that within such a brief period all four of the cities named will be at the end of present and proposed supplies. Assuming that these cities increase in population only 25% in each decade from 1890 to 1920, their population in the latter year would be over 5,000,000, allowing for no increase in territory meanwhile. But both New York and Brooklyn have annexed immense areas and some population in the half decade ending with 1895. These new districts are bound to grow rapidly in population, so that it is safe to say that the four cities will contain 5,500,000 people in 1920, within their boundary limits of 1895. To this population must be added that of a multitude of suburbs, many of which have already outgrown their present local water supplies, and practically all of which must then go to remote sources on account of the dense population which will exist on the drainage areas now in use. Some of these suburbs will be, through further annexation, parts of the four larger bodies politic under consideration. For purposes of water supply, and possibly other public services, a Greater New York will then be a necessity, provided it has not already become a reality by actual consolidation. Of course the New Jersey section of this great metropolis will remain politically separate, but physical necessities will at least suggest that harmonious action and co-operation in some things with the portion of the metropolis lying across the North River might be mutually advantageous. If only 500,000 people are allowed for in the suburbs, there will be 6,000,000 within metropolitan New York in 1920. It will require stern restrictive measures to so restrain the increase in the per capita consumption of water in progress for 20 years that it will not exceed an average of 100 gallons in 1920. But, assuming that this can be done our 6,000,000 of people will require 600,000,000 gallons of water at that date. As shown above, a new or additional supply for all these people will then be necessary, and a provision would naturally be made for 30 years in advance. Assuming only 20% increase in population for each decade it would be necessary to provide for 10,370,000 people, or more than a billion gallons a day, assuming the per capita consumption to remain at 100 gallons until 1950. A more careful study might show a greater population to be provided for in the year named, and it would take but few figures to show that only by heroic measures can the per capita consumption be kept down to the figures named for so long a period, judging from past experience.

Let us come from this very general discussion of facts, probabilities and possibilities to the concrete case of Brooklyn, whose officials are considering and must very soon provide more water. The local situation has been clearly set forth by Mr. I. M. De Varona, M. Am. Soc. C. E., Engineer of Water Supply, as shown by the abstract of his report printed in this issue. As to the possibilities for the future, Mr. De Varona reports on obtaining 100,000,000 gallons daily from the southern slope of Long Island, going farther to the eastward and taking a drainage area adjacent to that now in use. Mr. Wm. Worthen, Past Pres. Am. Soc. C. E., reports on a supply of like amount from the headwaters of the Housatonic River, on the east side of the Hudson, and from the Ramapo, on the west side of the Hudson.

We will not undertake a detailed discussion of the relative merits of these three plans, but in view of the future needs of the metropolitan district, set forth above, it seems desirable to consider the subject briefly from that point of view. And first it must be pointed out that the Housatonic and Ramapo schemes contemplate the diversion of large quantities of water from these rivers before they flow into the States of Connecticut and New Jersey, respectively, thus involving the question of interstate water rights. However Connecticut may look upon such a plan, it seems certain that New Jersey would fight it, no little opposition having been shown some ten or twelve years ago, when it was proposed to divert the Ramapo in a similar manner for the supply of New York city. Aside from this, or rather connected with it and accounting for some of the opposition, is the claim that New Jersey cities and towns need all the highland streams of the State, and especially the headwaters of the Passaic, for their own supply. Next it is to be observed that nearly twenty years ago New York city made surveys of the Housatonic drainage area, and that the waters here available, provided the interstate questions can be amicably settled, may perhaps belong to New York, on broad grounds of public policy, since it is claimed that at small expense they may be turned into the Croton watershed. As the two Croton aqueducts have a carrying capacity in excess of the minimum daily yield of the Croton drainage area the Housatonic might prove to be a most valuable supplement to the Croton.

A portion of the available supply from the Housa-

tonic could of course be used by New York without raising serious interstate questions, and this might be feasible for New York while not at all so for Brooklyn.

The Housatonic plan for Brooklyn involves a submerged crossing from the main land to Long Island beneath Bronx Kills, Little Hell Gate and Hell Gate. The Ramapo plan includes the same crossing and in addition a 6,000-ft. crossing beneath the Hudson. It is proposed to lay cast-iron pipes on the bed of the channels for each crossing. It is a serious question whether tunnels would not be far preferable.

The only reasons for going off Long Island, for a supply of the proposed amount, would seem at first thought to be because water enough could not be found otherwise. But Mr. Worthen estimates the cost of the Housatonic plan at $18,382,000 and the Ramapo, $14,630,000, while Mr. De Varona's estimate for a supply from Long Island is $24,500,000. The annual charges for the three plans are put at $726,000, $589,000 and $1,425,000 respectively, the Long Island scheme having not only the heavier interest and sinking fund requirements due to heavier capitalization to meet, but nearly $400,000 of pumping expenses in addition.

The annual cost per 1,000,000 gallons under the three estimates is $39 for the Long Island, $20 for the Housatonic and $16 for the Ramapo. On this basis alone the Ramapo plan would be the one to adopt. But taking into account the uncertainties attendant upon the appropriation of water which other States may claim, the difficulties involved in effecting the river crossings, the fact that the Long Island plan is far more susceptible than the others of development as the need for more water arises, and that the pumping expenses would be closely related to demand, it may be that the difference between the cost of the Long Island and the other plans is more apparent than real. Mr. White urges in his report, as will be seen by the abstract in another column, that these and other reasons may bring the cost of the Ramapo and Housatonic schemes quite up to the actual cost of the Long Island, the estimates for which he considers high.

Whatever may be said regarding the relative costs of the island and non-island plans, $39 per 1,000,000 gallons is not an excessive figure for water, and there are strong reasons why Brooklyn should exhaust local resources before going elsewhere for its water supply. In the first place, all available sources of supply will eventually be needed for the metropolitan district. By the time those near at hand have been developed it may be that some co-operative scheme will be possible, or at least some line of action which will avoid, so far as possible, all clashing of interests. It is easy to suggest that each municipality may look where it chooses for a present supply and all join together in the future. Present action should be in harmony with future probabilities. Moreover, it must be remembered that other centers of population must be supplied, aside from Greater New York.

For instance, Mr. White suggests that a supply of 1,000,000,000 gallons a day might be secured for the metropolitan district from the Delaware River. Years ago the upper Delaware was suggested as a proper source for Philadelphia. Many New Jersey towns, some of considerable population, are now drawing from the lower reaches of that river, which might advantageously join with that city in going to a point nearer the sources. The Upper Hudson, Lake George and Lake Champlain have been mentioned as possible sources for New York's supply; but Albany, Troy and other cities in that vicinity are now drinking sewage-polluted water and with other communities in that section, may yet appropriate a large part of any supply which it would be at all feasible to bring to New York.

It must be evident to any one who gives this great subject of future water supply careful thought that some means must be devised by many of our cities, and especially for those in the Greater New York district, to decrease the enormous waste of water now so common. The water consumption per capita in such of our larger cities as had public supplies from 30 to 50 years ago has increased from two to four times. The waste of water must be reduced. Even Brooklyn, with a per capita consumption of 79 gallons, could doubtless reduce this figure by an extension of the meter system. Could it no more than hold it down to the present point for a few years, the necessity for a new supply would be diminished.

The subject treated above is so broad a one that it has been impossible to do more than point out a few of the questions involved. Perhaps enough has been said to make it plain that any extensions to the water supply systems of the cities making up the Greater New York should be conceived on broad lines with regard to mutual needs and requirements; and, in addition, that it is quite as essential to so supervise the consumption and waste of water as to keep the latter down to the lowest figure as it is to lay out great schemes and secure the introduction of additional supplies.

The work of checking waste and curtailing needless consumption is a monotonous task, and the engineers who carry it out are apt to reap nothing better than maledictions, whereas professional fame and honors await those who plan and carry out great works for the increase of present supplies. Nevertheless, every careful student of the problem must admit that the work of checking waste and economising the available supply of potable water is that which effects the greatest public benefit.

LETTERS TO THE EDITOR.

Electric Traction on the Nantasket Beach Branch of the N. Y., N. H. & H. R. R.

Sir: Your readers may be interested to learn that after operating the Nantasket Beach Railway two months for the summer traffic by electricity, the electric machinery was carefully done up in white lead and cotton, and vulgar locomotives are now used for running the few passenger trains and the many coal trains which are run on this branch. William H. Harrison,

Braintree, Mass., Feb. 3, 1896.

The Avery Steel Post for Wire Fences.

Sir: In your article on wire fencing in Engineering News of Dec. 26, there is one mistake to which we would call your attention. You say at the top of the third column, p 418, that "holes have to be dug and to secure a firm anchorage prongs are formed at the bottom of the post." We would say that our posts can be driven, the prongs being so shaped as to allow this; but after it is driven it cannot be pulled out of the ground. It is not really necessary to have these prongs, as the post tapers, and after being driven cannot be pulled out of the ground. Yours truly,

The Avery Stamping Co.,
Henry W. Avery.

Cleveland, O., Jan. 29, 1896.

Proportions of Water to Be Used in Mortar for Cement Briquettes.

Sir: Referring to Mr. Cooper's letter in regard to water in mortar mixtures, in your issue of Feb 6, we take pleasure in laying before your readers a rule which has been adopted in our laboratory with entirely satisfactory results. It is as follows: First determine by pat tests the proper percentage of water for the neat cement, then reckon at 7% the amount of water required for the sand.

Thus if the neat cement takes 25% of water, the proper amount for a 3 to 1 mortar would be as follows:

1 part cement at 25%	.25
3 parts sand at 7%	.21
4 at 11½%	.46

Or for a 2 to 1 mortar of the same cement as follows:

1 part cement at 25%	.25
2 parts sand at 7%	.14
3 at 13%	.39

This rule gives proportions of water which are entirely satisfactory for ordinary commercial mortar sands; a little less can be used with standard test sand. For rammed work we are confident these proportions should not be exceeded; if they are the mortar will be "sloppy." For work which is laid with a trowel, more water is advantageous. The rule is also quite satisfactory for concrete, if the stones are moistened before they are added to the mortar. Yours truly,

Booth, Garrett & Blair.

Philadelphia, Pa., Feb. 8, 1896.

Employment for Engineering Graduates.

Sir: My attention has been called to the editorial in your issue of Jan. 16, with regard to the experience of recent graduates from engineering schools, in which you quote the statistics given in a paper by Mr. Floy, in the "Engineering Magazine." As Mr. Floy received replies from only about one-half of the young men to whom he addressed letters, you draw the conclusion that it is exceedingly probable that very few of those who did not reply had secured positions. I desire to state that this conclusion is entirely erroneous, at least with regard to the graduates in civil engineering from the Massachusetts Institute of Technology. Out of a total of 28 students in civil and sanitary engineering who graduated last June from this Institute, every one had secured employment within a few months after graduating, while many had secured positions before they left the school, and others did so within a few weeks. Some of these young men have had several opportunities; in fact, I feel that it is not an exaggeration to say that if we had graduated twice as many men, they would all have found employment within a reasonable time, for we have had since last June many applications for our graduates which we were unable to fill. All of these men are working in civil engineering. In my opinion, the principal reason why Mr. Floy's letters were not all answered, is that they did not reach the persons to whom they were addressed, and also that some of the young men may have been careless, negligent, or indifferent with regard to the matter. Yours very truly,

Geo. F. Swain,
Prof. of Civil Engineering, Mass. Inst. of Tech.

Boston, Mass., Feb. 6, 1896.

(This is a case where the editor of Engineering News had rather be wrong than right. We are exceedingly pleased to learn that the graduates of the Massachusetts Institute of Technology are so fortunate in securing positions.—Ed.)

Monumenting Government Surveys.

Sir: For additional information on this subject, you will find a very flexible system illustrated in Engineering News, July 9, 1881. It had previously been brought to the attention of the United States Land Department at Washington. About this time Land Commissioner Williamson called a convention of United States Surveyor-Generals to consider matters of public interest: This particular system of monuments was deemed worthy of consideration; it was examined from a model furnished for this purpose. An infringement on the above was then patented by the Surveyor-General of California, and contracts were let with this monument specified to Col. Geo. Sheetz, of Colorado. This called forth an injunction and the publication cited: This patent controls any system of interchangeable marking, is owned by the writer and a short term remains, therefore, I hereby donate to the public its free and undisputed use. Isaac Leskard.

University Park, Oregon, Jan. 22, 1896.

(The essential features of the monument referred to above may be thus described: The fluted shaft of cast steel is 3½ ft. long, and the bottom disk has an inverted cone which rests in the socket of a brass point buried in the earth and marking the corner. This brass cone and flange would remain even if the post were removed. Near the top of the post are vertical grooves for the reception of figures or letters of glass or other material, and these are held in place by a keyed disk-cap, which also contains grooves for letters on its under side. The cap is finished on top by four thin flanges, marked with the cardinal points and set in the proper direction. In a personal letter Mr. Leskard highly praises the United States system of public land surveys as a grand conception of very simple methods. But he also points out that the ordinary wooden section post, as now authorized, and used to mark these surveys, is very liable to removal or decay, and the uncertainty regarding these corners is a fruitful source of litigation and ill-will. When a corner is found, its marking is often so ambiguous as to require miles of retracing to establish its validity. Even in timber sections, where blazed trees furnish some clue to the bearings of the corner, trouble arises. He mentions one strip of land, 200 ft. wide and extending one mile along a section and including a public highway, that now shows two sets of blazed stumps, but no valid corner. The title to this strip has been in the courts for years because of the lack of a permanent monument.—Ed.)

Early Suspension Bridges Over the Niagara Gorge.

Sir: In your issue of Jan. 2, Mr. Orrin E. Dunlap, after noting the report that a "new steel arch bridge" is to be constructed over the Niagara gorge, writes: "The first step in the construction of a bridge was taken when ropes were carried across the river on an ice-bridge." Continuing, he writes:

On Jan. 10, 1889, the Niagara gorge was visited by a wind storm of such destructive force as to break a fastening of one of the principal storm stays of the bridge, which left it to the mercy of the gale, with the result that the entire suspended structure was carried away and fell on the banks and in the river, leaving nothing but the towers and the cables.

As Mr. Dunlap seems not to have written from personal knowledge of the facts, he was probably mis

informed concerning them. The erroneous paragraphs above cited refer to the upper suspension bridge, the second one constructed. In Mr. G. W. Holley's book, published in 1872, it is described as follows:

The new suspension bridge—as it was then called—just below the Ferry at the Falls, was built in 1868. Its length is 1,200 ft., the longest structure of the kind in the world, and also the narrowest of those designed for carriage travel. To this fact, its narrowness it probably owed its safety from destruction during a fierce gale, which occurred in the fall of 1869 (not 1889, as stated by Mr. D.). The fastenings or dowels of several of the guys on the Canada side were torn out, and the bridge, at its center, deflected down stream more than its width. Then its undulations from end to end—like a stair carpet between the two persons who are shaking it—were frightful, and for a time it was feared that either the cables or towers must give way. A physician residing on the American side was returning from Canada when the gale struck the bridge. He was blown prostrate against the lower side, and was obliged to draw himself along by the railing to reach the American shore. After the gale the old guys were made fast again and new ones added.

Mr. Charles Eliet, in 1848, built the first bridge over the chasm 1½ miles below the Falls. He offered $5 to any one who would get a string across it. The next windy day all the boys in the neighborhood were kiting, and before night a lucky youth landed his kite in Canada and received the reward. Of this little string was born, so to speak, the large cables which support the present vast structure.

This bridge was an excellent auxiliary in the construction of the railway suspension bridge built by Mr. John A. Roebling. It was commenced in 1852, and the first locomotive crossed it in March, 1855. The towers are built of the Queenston limestone, are formed on the solid rock that forms the cliff on each side the river, and seem likely to stand while the world stands.

G. W. Holley.

Ithaca, N. Y., Jan. 30, 1896.

(We submitted proof of the above letter to Mr. Dunlap, who replies as follows.—Ed.):

Sir:—In my article which Mr. Holley criticises, I said:

In the early days crossing was made at this point (the point of bridge erection) by means of ferry boats, but the need of a bridge was early apparent, and the first step in its construction was taken when ropes were carried across the river on an ice bridge.

It is thus made clear that the bridge under discussion, which the proposed steel arch is to replace, is the "upper" or "new" suspension bridge. In fact, this is verified by Mr. Holley himself, for after quoting my words on the storm of Jan. 10, 1889, he says: "The erroneous (!) paragraphs above cited refer to the upper suspension bridge." The fact is the paragraphs are not "erroneous," but exceedingly accurate as to detail, which, as stated, is verified by Mr. Holley. Then Mr. Holley quotes from his book, published in 1872, and says the storm referred to by me occurred "in the fall of 1869 (not 1889, as stated by Mr. Dunlap)."

The storm that destroyed the bridge occurred just as I said it did—on the morning of Jan. 10, 1889, and the effect was exactly as I have stated. Because the wind blew in 1869, it is no reason why it shouldn't blow again in 1889.

But I am very much surprised to see an author of a book, published in 1872, pretend to quote from its pages and endeavor to mislead people, as does Mr. Holley. In quoting from his book, Mr. Holley should have stopped at the period following the words "must give way," for the experience of the physician next described did not occur until the night of Jan. 9, 1889, during the storm referred to by me, the physician being Dr. John Hodge, of this city. How then could it have been printed in 1872? If Mr. Holley will refer to p. 144 of his book, from which he quotes, he will find that the physician incident is not to be found there. His mixture of "modern" and "ancient" history is very sad.

Then again, Mr. Holley has much to say of the railway suspension bridge, stating that "the towers are built of the Queenston limestone, are formed in the solid rock that forms the cliff on each side of the river, and seem likely to stand while the world stands." It is remarkable that one who feels his ability to write on a subject in correction of another should not have known that the stone towers referred to "AS LIKELY TO STAND WHILE THE WORLD STANDS" were replaced by steel towers in 1886-87.

It is to be regretted that one who would pose as a historian of the '50's and '60s does not evince more accuracy as to events of more recent date, as the errors in Mr. Holley's criticisms force one to lose confidence in his earlier writings.

Orrin E. Dunlap.

Niagara, Falls, N. Y., Feb. 8, 1896.

The Melan Concrete Arch at Stockbridge, Mass.

Sir: I have just read with interest the description of a "Melan Concrete Arch of 100 ft. Span, at Stockbridge, Mass.," published, with an attractive illustration, in your issue of Nov. 7, p. 306. The picture of the bridge (apparently by photogravure) shows markedly to those who have seen and walked over it, the peculiar giving way, or sinking, a little to the left of the crown. And this peculiarity (which is rather greater on the other side—the side not seen in the picture), a sort of cork-screwy or wavy condition, has so interested us, who know the bridge, that grave doubts have arisen in regard to its solidity. Perhaps I might also add, in regard to its ability to resist the action of heat and cold (which, thermometrically speaking, is 100° hereabouts) in the expansion and contraction of the two components, iron and cement, of which the structure is built.

This interest is perhaps greater on account of the entire collapse of the first similar bridge which was put up there a year ago, possibly on the same system and by the same contractors as was this one.

As there is no allusion made in the article in question, doubtless by oversight, to the absolute failure of the first bridge, might we not indulge the hope that the writer of the article, who seems to be so familiar with the methods of construction, and the engineering difficulties encountered and avoided, would kindly append a statement concerning the first bridge and its self-destruction, to the end that we may the more clearly comprehend the advantages which this and the "Wildegg bridge in Switzerland" do really possess over substantial bridges of iron, built and resting on strong stone abutments.

Mr. Fr. Von Emperger, C. E., the writer of the article in question, will readily understand that this is submitted by a layman, having little technical knowledge of the mechanics of such structures, but who, in common with many other laymen (noticing the peculiar neglect in the descriptive article to allude in any way to the first bridge, and how its structural weakness was met and overcome), want "more light." That Mr. Emperger can most thoroughly do this is quite apparent from the careful and thorough manner in which he has not done it in your issue of Nov. 7.

Very respectfully, James F. Dwight.

Stockbridge, Mass., Nov. 23, 1895.

(In accordance with our rule where contributions offered for publication criticise the work of persons or firms, we submitted a proof of the above letter to Mr. Emberger and append his apply as follows:—Ed.)

Sir: In reply to the above inquiry by Mr. James F. Dwight, I cannot help saying that I am quite astonished at the tone of the same, which shows that interested parties are trying to give currency to unfounded doubts about the strength of the above-mentioned bridge. I am, however, much pleased to have some of your valuable space to give an explanation of what Mr. Dwight calls "the peculiar giving way, or sinking, a little to the left of the crown"—"a sort of cork-screwy, or wavy, condition"—although I specially called attention to this point and gave the reasons for it in my article when I said: "The banks of the river on each side were of unequal height, and consequently the face walls had to be made on a different grade, which naturally gives the arch an unsymmetrical appearance." I may say that the arch was to be of an equal thickness for a number of feet each side of the center. The coping line from the lower or left embankment runs tangentially into the circular center part, while the coping line from the higher, or right, embankment, being on a different grade, joins the center part with a break, not being tangential to the circular part over the center. This break in the coping may be taken by a layman for a sinking at that point, but everybody will notice that if any sinking had taken place, it would be visible in the soffit line of the arch, as well as in the coping line; moreover, there are no cracks whatever at or near the point in question. The weatherproofness of concrete made from Portland cement is now hardly ever questioned by the engineering public.

As to the "absolute failure of the first bridge," no such thing has taken place. The contract for building the same was given to a sub-contractor. According to the specifications, lines and levels had to be given by the supervising engineer.

When I went there for a visit the sub-contractor informed me that this had been done, and that the falsework, which was at that time completed, had been approved. This proved not to be the case, for on examining it I found that the falsework had only a span of some 90 ft., instead of 100 ft., and that it was about 3½ ft. too low in the center. The necessary changes were ordered and executed in my absence. The addition in the span of the falsework was constructed on the left, or Laurel Hill, side, by simply laying cross-timbers on frozen mud, without piles or anything else to keep them in place, and the remainder of the wooden arch was elevated by blocking up the lagging. Then concreting was immediately started on the abutments.

On my next visit a few days afterwards I found the arch completed, when it was, of course, too late to make any changes in the falsework. After removing the side moldings it was clearly visible that the unsupported cross-timbers on the left side had sunk at least 2 ins. during and immediately after concreting in the haunches, as might have been expected, and that the arch was, in fact, broken. This showed that a reconstruction was necessary. The sub-contractor decided to remove the main support in the center of the falsework, this being the easiest way of demolishing the structure. This, naturally, was not a failure of the bridge, but simply an unpleasant experience with an unfaithful contractor—a fact that may be interesting for parties who have to do with contractors to know, but which does not necessarily belong to a descriptive article on the building of a bridge. The only thing of engineering interest is, that although the falsework for this style of bridges may be built comparatively light, it has to be entirely unyielding, especially near the haunches, as the concrete before setting is like loose earth, and produces at these vital points a very strong side-pressure.

I need hardly say that this "failure of a falsework," as it may be termed, instead of "failure of a bridge," has nothing whatever to do with the system itself. The failure of a falsework during construction will destroy any bridge.

A case similar to this has come to my attention where an iron bridge failed because the county did not provide funds for a proper construction of piers, but afterwards requested the bridge company to make repairs, although the piers failed to carry an otherwise well-built superstructure.

Impartial men will investigate before forming any such judgment as the one given above, while other people, especially contractors, should not derive, from the splendid tests this bridge has stood, the conclusion that the Melan system can stand any fault in construction, but that it requires, like any other work, proper care in all its details, as well as a close supervision of subcontractors.

Fr. von Emperger.

Vienna, Austria, Jan. 3, 1896.

SWITCHING BY ELECTRICITY AT THE BROOKLYN BRIDGE TERMINALS.

The matter of electric traction on the cable railway of the Brooklyn Bridge has been very frequently discussed of late, but while there is little to be said in favor of its use as a substitute for cable traction across the bridge (for reasons noted in our issue of Oct. 17, 1895), there is much to be said in favor of its introduction as a substitute for steam traction in switching the trains from the incoming to the outgoing tracks at the terminals, not only on account of the freedom from the dirt and the nerve-harassing noise of the present steam locomotives, but also on account of greatly facilitating the train movements. Before describing the method of switching by electricity, which has recently been tried with success, it may be of interest to briefly describe the conditions of working.

The transfer of the trains from the incoming to the outgoing track has always been effected on the tail-switching system, and with the old terminals, the arrangement at the New York end required less use of the switching engines than at the Brooklyn end. The tracks entered the New York station on a straight line, and the cable extended the length of the platforms, so that the outgoing train gripped the cable while standing at the platform. As the Brooklyn station was on a curve, the cable could not be picked up at the platform, but the outgoing train had to be pushed out for a short distance to the gripping place, where it picked up the cable without stopping. With the new terminals at both the Brooklyn and New York ends of the bridge (Eng. News, Nov. 8, 1894, and July 4, 1895), the reverse curves of 100 ft. radius, by which the gantleted tracks diverge to pass on either side of the two island platforms, prevent the cable from being carried through the stations, and the trains have to be pushed out by some other power to the point where they grip the cable.

The arrangement is as shown in Fig. 1. A train arriving at A stops to discharge its passengers and is pulled out by a steam locomotive to the stub track

Fig. 1.—Plan of Switching Arrangements at Terminals of the Brooklyn Bridge.

E, and pushed back to the departure track C. Similarly, a train arriving on the other side of the platform, at B, is pulled out to the stub track F, and pushed back to D. The outgoing train, at C or D, when loaded, is pushed out to the point G, where it picks up the cable. This means that the crossing H, which is the crucial point of the whole system, must be crossed not only by the trains in making their regular movements from one track to the other, but also by the switching engines in running back to the stub track after pushing a train out from C or D to G, thus employing a shuttle or to-and-fro movement,

instead of a regular movement in one direction. A train cannot follow the preceding train until the engine of the latter has run from C or D to G and back across H to E or F. The importance of this will be seen when it is explained that the intention is to run trains during the rush hours on a headway of 45 seconds when the new terminals are completed, instead of 90 seconds, as at present. When the new terminal plans were adopted by the Trustees, in the face of the adverse report of a board of engineers appointed to consider the matter (Eng. News, April 21, 1888), this question of the switching movements was very much discussed. The switching has always been a disproportionately expensive part of the operation, and it was shown in our issue of Jan. 11, 1890, that while

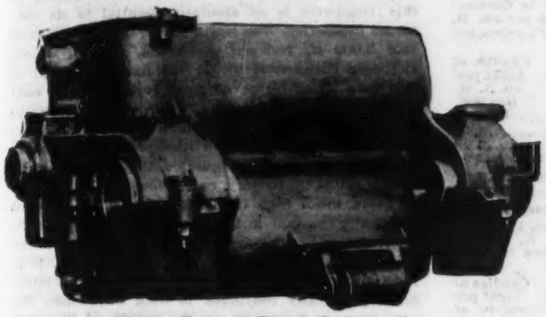


Fig. 2.—Motor for Electric Switching Car.

only 9% of the car mileage was made by the switching engines, this mileage cost 60.7% of the operating expenses, leaving 39.3% for operating the 91% of car mileage by cable. The traffic possibilities under this system of switching were carefully analysed by the late Mr. A. M. Wellington in our issue of Feb. 14, 1891, and while it is not necessary now to go into details, it may be said that he arrived at the conclusion that, apart from the danger of collision, due to the passing of every train twice over the crossing H, it was very doubtful if the headway could be materially reduced over that at present in use, and that it was practically impossible to reduce it from 90 to 45 seconds if switching locomotives were used. A system of switching by an independent short cable was at one time proposed, but would be impracticable on such curves and with such enormous traffic. It will be seen at once that if the separate switching engines are eliminated, and each train carries its own power for the switching movements, the traffic will be facilitated, and the constant and imminent danger of collision at the crossing H very materially reduced. This is the object aimed at in the electric switching system now under trial.

The successful application of electricity to street car traction was not considered by the authorities of the bridge as sufficient proof of its efficiency for handling trains, and it was not until the successful work of electric motors on the Metropolitan Elevated Ry., of Chicago; the Baltimore Belt Line, of the Baltimore & Ohio R. R., and the Nantasket Beach branch of the New York, New Haven & Hartford R. R., had been examined and reported upon by the engineers of the bridge, that it was decided to make a practical trial of electricity for switching the bridge trains. After some negotiations with the Westinghouse Electric & Mfg. Co., and the General Electric Co., a proposition from the latter was accepted, by which it agreed to equip one car, operate it for 30 days, and then, if the result should be unsatisfactory, restore the car to its original condition and bear all the cost of the experiment.

The plan is to equip one car of each train (four cars) with four electric motors, one on each axle, a collector on the roof taking current from the overhead wire which now supplies the current for lighting the cars (and may be used also for heating the cars). The train will be hauled by the cable, as at present, and at either end it will switch itself from one track to the other, and also run itself out from the station to the point where it takes the cable. In addition to this the trains will be able to approach the stations under control, using the motors if the train is stopped outside the station, while, under the present system, after dropping the cable on the down grade of the approaches, they run into the stations by their own impetus, under control of the brakes only. This will insure greater safety in foggy weather, and will possibly mitigate the present unpleasant effects of "coasting" round the curves. Then again, the motors can be used as auxiliary to the cable in wet weather if the cable slips through the grip in hauling heavily loaded trains up the 3.78% grade of the bridge. The motor cars can also haul trains across the bridge between midnight and 5 a. m., when the traffic is light and the cable driving plant is shut down for inspection and repair, thus replacing the steam switching engines which now haul the trains at this time. As described in our issue of June 13, 1895, the latest locomotives in use on the bridge weigh 79,900 lbs., with 57,400 lbs. on the four driving wheels, and with dry rails and favorable conditions, can haul a

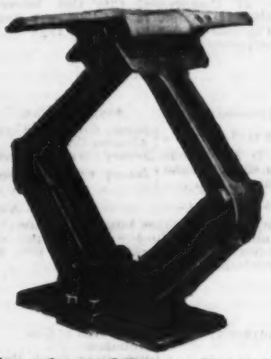


Fig. 4.—Current Collector on Roof of Car.

train of six empty or four loaded cars up the maximum grade at the speed of the cable trains, or 10.3 miles per hour, this load being equivalent to about 120 tons, the heaviest cars weighing 20 tons empty. The time now occupied in switching from one platform to another is about 85 seconds, and it is thought this can be reduced to 65 seconds with the new system. This is the time from starting from the incoming platform to stopping at the outgoing platform.

The car now being used is one of the ordinary passenger cars of the bridge, mounted on two heavy four-wheel trucks with 33-in. wheels, made by the McGuire Mfg. Co., of Chicago, these trucks replacing the original Pullman trucks, which were too light to carry the motors. There are four 50-HP. General Electric motors, two on each truck, or one to each axle, and these are known as Class 1,200, from the fact that under normal conditions each will exert a horizontal effort of 1,200 lbs. when mounted on a 33-in. wheel. The motors, as shown in Fig. 2, are completely encased and are water and dust tight. Each motor weighs about 3,000 lbs., and is suspended from the truck frame by two trunnions in the upper field, set in two bars, the outer ends of the bars resting on elliptical springs. The axle is thus relieved of nearly all the weight of the motor. The truck has coiled springs over the equalizer bars, between the axle boxes, and transverse elliptical springs. The weight of the car is about 19 tons.

At the base of each motor, facing the ends of the car, is a small roller which depresses the cable and allows it to pass the motor without injury, while a long iron bar runs beneath the truck and depresses the cable tilting sheaves of the gripping apparatus situated at G for raising the cable into the car grips, thus preventing these sheaves from striking the motors. The general arrangement of the motors on the trucks is shown in Fig. 3.

The armatures are of the well-known iron-clad type, the windings being sunk into slots in the armature core. The Eickemeyer winding is used on the armature, and by this method the crossing of two wires of large difference of potential is avoided. The insulation is substantial and each segment of the commutator is of hard drawn copper. The armature is mounted on a sleeve keyed to the shaft, which may be withdrawn without interfering with the armature structure. The field frame is of cast steel. The ratio of reduction between the armature shaft pinion and the wheel gear is 3.5 to 1. With this equipment and the regular train a speed of about 15 miles per hour may be attained.

The collector which takes the current from the overhead wire is shown in Fig. 4, and consists of a jointed diamond-shaped frame of metal set longitudinally upon the roof of the car, and carrying at right angles a bar, in the center of which is a roller. The arms are wide enough to preclude any possibility of missing contact in the lateral movement in passing over the curves. The diamond frame is depressible and expansible on the principle of the pantograph, allowing a play up and down to conform to the varying heights of the overhead wire. This system has been used on electric locomotives for mines, and with this collector the trouble of reversing is entirely done away with. Two collectors are fitted on the motor car. The power to run the car will be taken from the overhead wire already in position, supplying currents to the electric lights in the cars, but the extra current required for tractive power will be supplied from the Fulton St. feeder of the Kent Ave. power station of the Brooklyn Heights Electric R. R., the return wire being connected to the rails of the surface road.

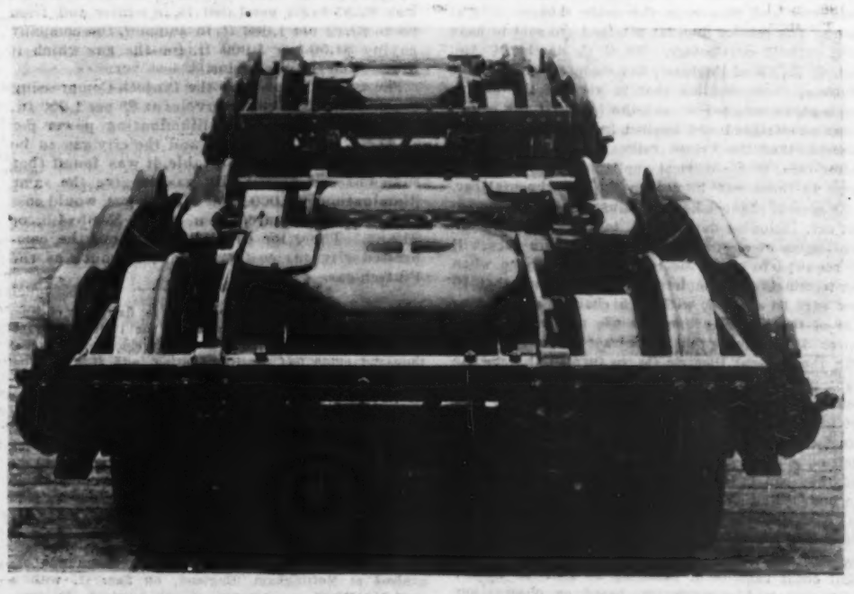


Fig. 3.—MOTOR TRUCKS FOR ELECTRIC SWITCHING CAR; BROOKLYN BRIDGE.

The operation of the motors is controlled by series parallel controllers of the L 4 type, similar to those which have given general satisfaction on the Chicago roads. The indicating dial of the controller is placed at the top of the platform rail, and is lettered "Series," "Multiple" and "Off," showing exactly the

position of the controller itself. The jointed reversing handle can be placed on or taken off the reversing switch spindle only when the controller handle points to the "Off" position, showing that there is no current in the motors at that moment. The controller itself has no effect until the long arm of this jointed handle is dropped into the "forward" or "reversing" notches in the reversing handle plate. There are two controllers, one on each platform of the car, and either controller will operate the four motors or any two of them, as may be desired.

The resistances, as well as the magnetic cut-outs, are placed beneath the car floor, and beneath each hood of the car is an automatic circuit breaker, placed within easy reach of the motorman. The operation of this device is instantaneous and is an effectual safeguard against any accident to the motor. These circuit breakers take the place of the main circuit hood switches, but are wired in multiple with each other instead of in series. To guard against any possibility of one being closed when the motorman is at the other end of the car and desires to open his main circuit, only one handle is provided. The handle cannot be taken off without opening the circuit breaker and when removed the circuit is locked open. As the motorman must take the controller and circuit breaker handles with him when changing from one end of the car to the other, all danger of complication is avoided.

The car is equipped with 12 electric heaters, manufactured by the Consolidated Car Heating Co., of Albany, N. Y., which system of heating has been extensively adopted for the electric surface cars in Brooklyn. The heater consists of a slab of porcelain, in front of which is a cylinder of porcelain wound with galvanized iron wire. These heaters have a maximum capacity of 40 sq. ft. radiating surface at 400° F., and five different temperatures, to suit the weather, can be obtained by mean of a controlling switch. We are indebted to the General Electric Co. for the accompanying views of the apparatus used.

The car has been given several trial runs, and on Feb. 8 the first official exhibition was made in the presence of Mr. Howell, the President, and several members of the Board of Trustees of the Bridge, together with Mr. C. C. Martin, Chief Engineer, and a number of engineers and electricians. The motor car was coupled to three of the ordinary passenger cars and the complete train of four cars was switched by the motors from the incoming to the outgoing platforms and thence to the cable sheaves several times. The results thus far attained are said to have been entirely satisfactory. Mr. C. C. Martin, M. Am. Soc. C. E., Chief Engineer, has made a report to the trustees, recommending that in view of the advantages above referred to, and the fact that the equipment as designed and applied has been a complete success, that the bridge railway be equipped with motor cars, with electrical appliances essentially the same as those now in use on the experimental car.

As several changes have been necessary in the present car, including new trucks, to adapt them to the application of electric power, and as more cars will be required to equip the road for full service when the terminals are completed, he recommends that 16 new cars be ordered, with such changes as observation of the motor car now in use may seem to require. He suggests that a contract be made at once with the General Electric Co. to furnish the electric plant necessary to equip 16 motor cars, the equipment to consist of dynamos, motors, controllers, etc., not including engines for the power plant nor heaters for the cars, as it is proposed that the trustees shall obtain new cars adapted for motor attachments, and they can procure the engines and heaters from the builders as cheaply and as well as can the General Electric Co. He further suggests that he be authorized to proceed at once to prepare plans and specifications and obtain estimates for a complete electrical outfit capable of handling 20 four-car trains, and expresses his conviction, based on observation on the motor car now in use, that 16 trains, with motor cars, will do more efficient service than 20 trains switched by locomotives.

Electric wires are all to be underground in St. Louis, Mo., after Jan. 1, 1900, and no permits will be granted for overhead wires after the end of 1896. The ordinance applies to tubes or cables conducting electricity across streets as well as to wires.

The New York & New Jersey Bridge Co. has had a bill reported favorably by the New York Senate extending the time of completion to 1897.

THE RELATIVE COST OF CAR LIGHTING BY PINTSCH OIL GAS AND BY COMPRESSED CITY GAS.

We have been furnished with the results of some tests recently made by Dr. E. G. Love, official gas examiner of New York city; Prof. W. H. Chandler, of Lehigh University, and Profs. J. E. Denton and D. S. Jacobus, of Stevens Institute of Technology, concerning the relative economy of compressed city gas and Pintsch oil gas for car lighting. They show that the Pintsch gas has about 45 times the illuminating power of compressed city gas, and although it costs more per 1,000 cubic feet the cost for a given amount of light furnished is only about 40 % of the cost of compressed city gas. The following are the results of the tests:

Value of Compressed City Gas burned in Gordon-Mitchell Lamps, in candle-power hours per cu. ft. (Photometer set to measure rays at 45° below the horizontal).

Authority.	Source of Gas.	Candles of Light per cu. ft. of Gas per Hour.
Dr. E. G. Love	Jersey City Gas Works	3.31
	Altoona Gas Works	2.20
Prof. D. S. Jacobus	Jersey City Gas Works	2.95
Profs. Chandler and Denton	Jersey City Gas Works	3.6
	Average,	3.01

Value of Pintsch Gas burned in Safety No. 1 Argand Lamps, in candle-power hours per cu. ft. (Photometer set to measure rays at 45° below the horizontal).

Authority.	Source of Gas.	Candles of Light per cu. ft. of Gas per Hour.
Dr. E. G. Love	Hoboken	13.19
	Broadway Cable Ry.	13.40
	D., L. & W. R. R.	12.66
	D., L. & W. R. R.	14.34
Prof. Jacobus	D., L. & W. R. R.	14.26
*Profs. Chandler and Denton	D., L. & W. R. R.	14.6
	Average,	13.74

*The tests were made in a car.

The average results make the comparative illuminating value of an equal bulk of Pintsch and city gas as 4.5 to 1.

In connection with the above figures we learn that a prominent railway which has been operating some 300 cars equipped for lighting by compressed city gas has secured a report by two well-known experts respecting the comparative cost of lighting by this gas and by Pintsch gas. This report showed that the actual cost to the company of the city gas, compressed and delivered into the car receivers, was $2.85 to $3 per 1,000 ft. in winter and from $3 to $3.12 per 1,000 ft. in summer, the company paying $1.50 per 1,000 ft. for the gas which it takes from the city mains.

The works operated by the Pintsch Compressing Co. deliver gas in car reservoirs at $5 per 1,000 ft., and taking the relative illuminating power per cu. ft. of the Pintsch gas and the city gas to be 4.5 to 1, as in the above table, it was found that sufficient compressed city gas, to give the same illumination as 1,000 ft. of Pintsch gas, would cost at the lowest figure given above, $2.85x4.5, or $12.82. Thus, for equal illumination, the compressed city gas costs 2⅛ times as much as the Pintsch gas.

Des Moines, Iowa, is engaged in a fight for cheaper gas. The gas company, owned by the United Gas Improvement Co., of Philadelphia, was charging $1.70 per thousand cubic feet for illuminating, and $1.30 for fuel gas. The council passed an ordinance requiring the reduction of the rates to $1.30 and $1, respectively. The company began to fight the matter in the courts, but finally agreed to compromise by making the rate $1.30 for both illuminating and fuel gas, and to reduce the price 5 cts. every two years, so that the price will be $1 at the end of ten years. The company offers to do this if the council will repeal the present ordinance and give a 15-year contract for the use of the streets for the gas mains.

The British Association of Water Engineers was organized at Nottingham, England, on Jan. 11, with a probable initial membership of one hundred. In commenting on the discussion regarding the advisability of adding another to the many English technical societies, the London "Contract Journal" expresses the opinion that this one is really needed. The Institution of Civil Engineers, it thinks, cannot possibly take up all the details which water-works men need to discuss. The Association of Municipal Engineers only includes officials connected with water-works owned by the cities and towns, leaving out an important class of men connected with private water companies. The association has as yet effected only a temporary organization, with Mr. D. M. F. Gaskin, M. Inst. C. E., Water Engineer to the Nottingham Corporation, as President.

THE IMPROVEMENT OF THE DOCKS OF NEW YORK CITY.

The report of the board of consulting engineers on the New York water front property has been published. This board, consisting of Gen. Thos. L. Casey, late Chief of Engineers, U. S. A., Mr. George S. Morison, Past-President Am. Soc. C. E., and Prof. Wm. H. Burr, generally commends the work already done by Mr. George S. Greene, Jr., Chief Engineer of the New York Dock Department, and recommends the construction of a large graving dock, among other improvements suggested.

The board points out that the city of New York has been built upon and lives upon foreign commerce more than anything else, and the development of this commerce is an absolute essential to its continued prosperity. The North River, with its width of over 3,000 ft. between pier-heads, straight course and deep channel, is by far the most important of the three water-fronts of New York, and the only one adapted to the handling of large vessels; and to this river the board mainly confines its report.

As the physical characteristics of this river must regulate the class of construction, these are described as follows: At the Battery, rock is found at less than 50 ft. below mean high tide, and this depth continues practically constant to Barclay St. Above Barclay St. the rock lies deeper, say 80 ft. up to Leroy St., where the depth again increases. At Christopher St. it is 124 ft., and nearly 200 ft. at 14th St., and this latter depth practically continues to 34th St., where the rock rises again rapidly on the bulk-head line, but continues very deep on the pier-line. Over this rock along the water front is a material which may be described simply as mud, though it contains in some places fairly good sand. Any construction, from Barclay St. to 34th St., must be founded in the mud, and the board then discusses the real value of mud flotations, as follows:

A pile driven into mud is surrounded by the mud, which adheres and sticks to its surface; the pile becomes, as it were, a part of the mud, and it stands there; in this way a single pile can be put down so that it stands practically firmly. On the other hand, though the pile cannot be moved in the mud, the mud itself is a soft, compressible material, and the pile foundation can bear no more than the mass of mud; the piles cannot settle in the mud, but they cannot help settling with the mud. If, therefore, a weight is put on the mass of piles in a pier exceeding that which the mud itself can bear, the mud and the structure will go down together as a whole. This is the invariable experience with structures built in this way. The movement, being that of a large mass, is slow, but it is [illegible] and [illegible] a pier carrying 500 lbs. per foot is supported by 1,000 piles is no evidence that a pier of equal area supported by 2,000 piles would not settle with a weight of 1,000 lbs. per sq. ft. The ultimate capacity is not measured by the supporting power of the separate piles, but by the supporting power of the medium in which the piles are imbedded.

The general dock-plan of 1871, upon which all recent work has been based, provides for a bulk-head about 180 ft. west of the old crib bulkheads of very irregular shape, and would give a marginal street, including the old street, 250 ft. wide. Outside of this bulkhead wall, piers of varying length have been built. This bulk-head wall is a retaining wall, and as this wall and the earth-filling behind it are floated on mud, the board regard the wall as now built as a unique construction, satisfactorily solving a difficult problem and as well worthy of the "most careful study and the strongest commendation." The pier construction of the present Dock Department is also highly praised.

Measured on the bulkhead line, between the Battery and Gansevoort St., there are 13,439 ft., a little more than 2½ miles, of pier property. Of this the city owns 8,089 ft.; various private owners, 3,433 ft., and 1,917 ft. belong to railways. Of this 13,439 ft., foreign steamships lines use 1,779 ft.; coasting steamship lines, 1,861 ft.; railways, 3,833 ft.; ferries, 1,116 ft., and there is appropriated to miscellaneous uses, including inland steamboat lines, 4,800 ft. In other words, of this 2½ miles so well adapted for the purposes of foreign commerce, only 13.24% is so utilized, and only 27.08% is occupied by all classes of ocean going steamships, while 28.80% is used by railways. If the ferries and railways could be confined to one-half mile of this front, there would remain two miles, enough for 30 to 35 first-class steamship piers, for the purposes of foreign commerce.

To bring about this latter use, the board suggests that future leases always favor this class to the exclusion of other traffic, and that railway ferries should be reduced in number and confined to a smaller frontage. No material changes in the pier-

plans are desirable, and the two-story sheds, such as have been built on Pier 14, seem to give as much capacity as is desirable, and probably approach very nearly to the limit of safe mud flotation. Warehouses of larger capacity could safely be built on piers founded on rock, but such construction would be very unwise above Barclay St. The board believes, however, that the entire passenger service, for ferries and steamship lines, could be handled on the second story of piers with great advantage to all concerned; especially, as such passengers could then be taken across the marginal street on bridges, leaving this street unobstructed for freight traffic.

The use of this marginal street in connection with piers is deemed of much importance. This 150 to 250 ft. street must be regarded rather for commercial use than ornament; and passenger traffic should be removed from it wherever possible. The report points out that a graving-dock is necessary where iron steamers congregate. These latter require cleaning once in six months, at least, and foreign ports generally provide for this. Liverpool has 22 graving docks conveniently scattered through its dock system; Southampton has five of these docks, one 750 ft. long on the floor; New York has only the two Simpson timber docks in the Erie Basin, in Brooklyn, remote from the steamship piers and too small to take in an Atlantic liner. The steamers of the American Line must now be taken 300 miles, to Newport News, for docking purposes. The board regards the providing of suitable graving-docks as a proper function of the Department of Docks, and it believes that they should not be left to private enterprise, but that they should be made a part of the dock system of the city with charges arranged to encourage commerce rather than to yield large profits to owners. As such docks should be founded on rock where possible, a good site for them will be found on the North River, between 49th and 431 Sts., extending inland 800 ft. to 11th Ave. Three docks of different capacities, should be built in this neighborhood, and the number should ultimately be increased to five or seven.

This report of the Board is simply a preliminary one, and in succeeding reports it will take up the improvement of other parts of the harbor, warehouse building, etc.

REPORTS ON AN ADDITIONAL WATER SUPPLY FOR BROOKLYN, N. Y.

For some years past the officers in charge of the water supply of Brooklyn, N. Y., have been struggling to keep pace with the increasing consumption and waste of water in that city. Failures of city councils to authorize the necessary expenditures have delayed beginning new construction until demand has almost or quite equalled supply. A few years ago an important extension to the works was made, but it had been delayed so long that hardly was it completed before further extensions became immediately imperative. Such was the condition when Mr. Alfred T. White, Commissioner of City Works for the past two years, assumed office at the beginning of 1894. He soon perfected arrangements by means of which 25,000,000 gallons was added to the available daily supply, driven wells being sunk for this purpose. This gave sufficient relief to permit ample time for a careful study of possible additional supplies and for the construction of works when the most available source should be determined. More than this, it scarcely allowed.

In July, 1894, Mr. White was given authority to make a thorough investigation of the water question. The results of the studies which he instituted have just been made public in the form of four reports, one by Mr. White, one by Mr. Wm. Worthen, Past-Pres. Am. Soc. C. E., and one by Mr. I. M. De Varona, M. Am. Soc. C. E., Engineer of Water Supply. From Mr. White's report it appears that the investigation was confined to sources capable of yielding 100,000,000 gallons a day, larger as well as smaller possibilities being left out of consideration. Of the possible sources of supply nearest at hand, three were chosen for investigation and assigned to engineers as follows: The Housatonic and the Rockaway water sheds to Mr. Worthen and to Mr. Robert Van Buren, M. Am. Soc. C. E., formerly Chief Engineer of the City Works Department of Brooklyn; the Long Island water shed was assigned to Mr. Varona. Mr. Van Buren withdrew from the work before its completion, so Mr. Worthen reported alone.

The Long Island Plan.

The report of Mr. De Varona will be reviewed first, since it contains much information regarding the present source of supply and the conditions relating to past and future yields and consumption.

The computations of yield in this report are based upon rainfall and gagings in 1894. During the months of June, July and August, of that year, the total rainfall was only 1.96 ins., or less than half the lowest precipitation recorded for the vicinity of Brooklyn since 1826. The total rainfall for the year 1894, as recorded at the Hempstead storage reservoir, was 36.88 ins., against an average of 43.16 ins. for the past 70 years, and a previous minimum of 32 ins. in 1867. The rainfall from 1826 to 1895, inclusive, both by years and by the summer periods of June, July and August, is given in Table I, the foot notes to the table indicating the places at which the records were kept. The figures for population and consumption in Brooklyn and New York, from 1870 to date, given in Tables II and III, were compiled by Mr. De Varona to aid in forming an opinion regarding future demands upon the system. Like the rainfall statistics, they are of value for other studies, and so are included here. Mr. De Varona states that the figures for population show that if Brooklyn's yearly increase for the last two decades continues, its population would be doubled in about 20 years, or at the rate of 3.35% a year. The increase in New York is at a lower rate. Brooklyn has a large sparsely settled area, which was doubled recently by annexation, and which may be still further increased in the same way. Add to the uncertainties connected with these areas the possibility of consolidation with New York city and the continued progress of the engineering and industrial arts and, Mr. De Varona thinks, the futility of planning for more than 20 years in advance of the date at which new works would be completed is evident. The average per capita daily consumption in Brooklyn was 79 gallons in 1895. Assuming 100 gallons at the end of the period, then an increase of 1,000,000 in population would require an additional supply of 100,000,000 gallons, the figure used by Messrs. Varona and Worthen.

Going eastward from the easternmost point of the water shed on Long Island which is already appropriated for Brooklyn's supply, eleven streams worthy of consideration were found from which water could be conveyed by gravity to one or the other of three main pumping stations. The next two possible sources to the eastward required long conduits, one of which would be difficult and costly to construct, while the other would be a force main, thus requiring duplicate pumping. The combined minimum supply from these two streams would be only some 12,000,000 gallons, so they were excluded from further study.

Gagings of the above eleven streams, made during the very dry summer of 1894, mentioned above, showed a minimum flow of 80,000,000 gallons a day, or only 400,000 gallons per sq. mile, the drainage area being at least 200 sq. miles. To make up the remaining 20,000,000 gallons of the amount desired four driven well pumping stations are required, for operation during say four months in the year. These would not be necessary, Mr. De Varona states, except for the very conservative basis on which his estimates are made.

The yield from the drainage area of 65.6 sq. miles, from which Brooklyn formerly drew its entire supply, was 48,000,000 gallons, equivalent to 41.7% of the total rainfall, or 15.38 ins. of a total rainfall of 36.88 ins. This was an average of 731,707 gallons per sq. mile, of which 243,902 gallons was collected from streams and ponds, and 467,805 gallons was gained by pumping from driven wells. Of this total drainage area, however, 10 sq. miles gave poor results and, excluding this, the remaining 55.1 miles yielded 762,250 gallons per sq. mile, which was 43.4% of the total rainfall, or 16.01 ins.

The drainage area from which the Brooklyn supply is drawn has recently been extended to the east, and the new water shed included has an area of 101.2 sq. miles. Of this, however, only 88.5 sq. miles was utilized in 1894, and this was not drawn upon to its full capacity. Developments since completed and a small amount of work proposed, Mr. De Varona estimates, would give a yield of 730,000 gallons per sq. mile from this area, or about 74,000,000 gallons. The developments already under way have assumed 60,000,000 gallons yield, and this figure, added to the 48,000,000 gallons of the original water shed, gives 114,000 gallons as the minimum daily supply from the drainage area thus far appropriated. Turning now to the proposed additional works, these would collect the rainfall from 200 sq. miles of territory, utilizing eleven of the larger streams, which gave a combined minimum flow, by actual gaging, of 80,000,000 gallons in 1894. Adding 20,000,000 gallons, which it is proposed to collect from driven wells, there results the 100,000,000 gallons desired, which with the yield from the present area would give a combined supply of 214,000,000 gallons a day. If the same yield were assumed for the new as for the old area, 730,000 gallons per sq. mile, instead of only 500,000, the extension would give 146,000,000 gallons, making a total of 260,000,000 gallons.

The conduit for the extension under discussion would begin at Babylon, 30.4 miles from the Ridgewood reservoir, and continue eastward for 25 miles to the Connecticut River, a small stream on Long Island.

Three main pumping stations, located at Babylon, the Connetquot and Connecticut Rivers, would raise the water into elevated tanks and thus pass it to the Ridgewood reservoir. The pumping engines would all be of the triple expansion type, these and the boilers being about 50% in excess of actual requirements. All the conduits have been figured for a safe delivery 12½% in excess of the required capacity. One or more supply ponds would be built on each of the eleven streams, but little or no attempt would be made to provide storage capacity, owing to unfavorable conditions. It is on the latter account that the driven well stations are needed for use in summer. The aggregate capacity of the pumps at the three main stations would be 157,500,000 gallons, there being three 125,000,000-gallon pumps at the Connecticut River station, three 25,000,000 at the Connetquot River and three 15,000,000-gallons at Babylon. The combined capacity of the boilers for these three plants would be 4,200 HP. By doubling the required capacity at the driven well plants, eight 5,000,000-gallon pumping engines and eight 20-HP. boilers would be required.

The elevated tanks would each be of steel or iron, 50x50 ft., on steel towers 147, 182 and 218 ft. high, respectively, at the Babylon, Connetquot and Connecticut stations.

The collecting pipes east of the Babylon pumping station vary in size and number with local conditions, owing to the fact that the supply from eleven streams and from driven well plants are brought to three stations, and also to the topography. The conduits range in size from 3.92 to 5.33 ft., and in number from 1 to 5, there being five 3.92-ft. conduits between two points. The aggregate length of these collecting conduits is not given, but the distance between the easternmost and westernmost station is about 25 miles, and from the easternmost station two 81-in. riveted steel force mains extend for 30.4 miles to the present Ridgewood reservoir.

The villages and settlements in the drainage area are given as eleven in number, with populations ranging from 275 to 3,000 each, and aggregating 1,975, or about 97 per mile.

The estimated cost of the works outlined above is $24,500,000, divided as follows:

Land, water rights, special damages and legal expenses	$4,000,000
Supply ponds, gate houses and appurtenances	2,000,000
Pumping stations, complete	1,400,000
Elevated tanks and towers	180,000
Conduits and appurtenances	14,820,000
Total	$22,400,000
Contingencies, engineering, interest, etc.	2,100,000
Total estimate	$24,500,000

In arriving at the yearly charges of this scheme a working duty of 100,000,000 ft.-lbs. has been assumed for the main pumps, and of 60,000,000 for those at the driven well stations. The working efficiency of the boilers was assumed as 70%; thermal value of the coal, 14,000 B. T. U.; and its cost per gross ton delivered, $4.50. Interest and sinking fund charges of 3½% each were allowed.

On the above basis the yearly charges would be as follows:

Pumping, including interest and sinking fund	$393,474
Maintenance and repairs	38,000
Interest, exclusive of above allowance	808,500
Sinking fund " " "	194,758
Total	$1,424,73

Cost per 1,000,000 gallons delivered:

Pumping expenses	$10.78
Maintenance and repairs	1.04
Interest	22.15
Sinking fund	5.06
Total	$39.03

It is thought that the works could be built in four years. If desired the extension could be made in say three sections, at intervals of six or seven years.

The Housatonic or Ten Mile River Plan

The proposed supply from the Housatonic drainage area, reported on by Mr. Worthen, would be taken from a branch known as the Ten Mile River. This stream has a drainage area of 180.65 sq. miles, 34 of which is in the State of Connecticut. Mr. Worthen names two reservoirs in the water shed, and a distributing reservoir of 4,000,000,000 gallons capacity, about two miles northeast of White Plains. The reservoirs would have earth embankments and concrete heart walls. From the lower reservoir in the water shed, with a high water level 440 ft. above mean tide, water would be conveyed to the White Plains reservoir, with a high water line 310 ft. above tide, by means of a conduit partly in tunnel and partly composed of steel pipe. In tunnel the conduit would have a diameter of 8 ft., there being an aggregate of 131,480 ft. of this. The remainder of this conduit would be composed of two 74-in. steel pipes, extending, altogether, a distance of 56,780 ft., making, with the tunnels, over 29 miles of aqueduct in this part of the work. Across the Croton Valley the pipe conduits would be supported on steel trestles.

From the White Plains reservoir to the present Ridgewood reservoir would be a distance of about 36 miles, making the full length of aqueduct 65 miles. Over this route water would be conveyed by means of two 65-in. steel conduits, except at the crossing of the Bronx Kills, Little Hell Gate, Ward's Island and Hell Gate to Astoria, where two 5-ft. cast-iron pipes would be used. For the most part the conduit from the White Plains reservoir to Brooklyn would be laid in public highways. The population on this water shed is given as 4,840, scattered through twelve towns.

The estimated cost of the Housatonic plan is given by Mr. Worthen as follows:

Pawling to White Plains Reservoir.

131,480 ft. 8-ft. tunnel and lining,	@	$29.42	$3,868,141
113,520 " 5-16 in. steel riv. pipe, 74 in. diam.	"	12.32	1,398,566
113,520 ft. coating for pipe	"	.65	73,788
8,500 " steel trestle	"	14.00	119,000
56,760 " excavation	"	11.20	635,712
Total			$6,095,207

White Plains Reservoir to Ridgewood Reservoir, Excluding Submerged Pipe.

17,000 ft. 7-16 in. steel pipe, 65 in. diam.	@	$14.87	$252,790
191,000 ft. 3-8 in. steel pipe, 65 in. diam.	"	12.75	2,435,250
90,600 ft. 5-16 in. steel pipe, 65 in. diam.	"	10.62	962,172
298,600 ft. coating for pipe	"	56	167,216
149,300 " excavation, White Plains to Astoria	"	6.25	933,125
			$4,750,553
39,600 ft. excavation, Astoria to Ridgewood	"	4.70	186,120
Gates			95,000

Crossing of Bronx Kills, Little Hell Gate and Hell Gate

4,600 ft. 60-in. cast iron pipe	$575,000
Storage reservoirs	4,000,000
436 acres right of way Pawling to White Plains Reservoir @ $100	43,600
Damage to water powers	200,000
Maintenance capitalized at 3½%	300,000
Total	$16,245,480
Contingencies, 15%	2,436,822
Total estimate	$18,682,302

The Ramapo and Walkill Plan.

The Ramapo supply, reported on by Mr. Worthen, would be drawn wholly from that portion of the stream located in New York State, but this tributary of the Passaic would have to be supplemented by 27.18 miles of the drainage area of the Walkill, in New Jersey. Numerous reservoirs would be built. From the head of the aqueduct to the Hudson River, about 14 miles, the conduit would consist of 35,427 ft. of 7-ft. tunnel, and two parallel steel 62-in. conduits, each 39,878 ft. long. The Hudson River crossing would be effected by duplicate 5-ft. cast-iron pipes 6,000 ft. long. From Hastings, on the east side of the river, the two parallel pipes would again be of 62-in. steel, and after reaching what is known as the Southern Boulevard their route to and across the Kills and the East River to Ridgewood reservoir would be the same as for the Ten Mile supply conduit from the White Plains reservoir.

The total length of aqueduct on this line, including river crossings, would be about 44 miles.

As to quantity and quality of water, Mr. Worthen states that the Croton is taken as the standard for each scheme. The estimates for the value of the water powers effected are based on figures given in the Reports of the Tenth Census of the United States.

The estimated cost of the Ramapo scheme is as follows:

Mahwah Reservoir to Ridgewood.

33,427 ft. 7-ft. tunnel and lining,	@	$27.26	$911,220
35,340 " ¾-in steel pipe, 6 in. diam.	@	12.37	443,340
311,360 " 5-16 in. " " 62 in.	"	@ 10.25	3,191,440
347,200 " coating for pipe,	@	54c	187,488
Bridges and culverts			21,000
39,878 " excavation, Mahwah to Hudson			761,250
95,040 " excavation, Hudson River to Astoria,	@	$5.00	475,200
39,600 " excavation, Astoria to Ridgewood,	@	$3.75	148,500
Total			$6,139,438

Hudson River and Hell Gate Crossings.

12,000 ft. 5-ft. cast-iron pipe,	@	$90.00	$1,080,000
4,600 " " " "			575,000
			$1,655,000
Gates			$90,000
Storage			$4,000,000
167 acres right of way, Mahwah to Hudson River,	@	$50.00	8,350
Damage to water powers			800,000
Maintenance capitalized at 3½%			300,000
			$12,982,788
Contingencies, 15%			1,947,418
			$14,930,206

Comparison of the Three Plans.

In Mr. De Varona's comparative summary of the three plans, some information is given not included in Mr. Worthen's report as follows:

The yield per square mile from the Housatonic drainage area of 180.65 sq. miles would be 554,000 gallons per sq. mile, corresponding to 11.63 ins. of rainfall, or 26.4% of the yearly precipitation, which is taken as 44 ins. The four reservoirs proposed would give a storage of 19,235,000,000 gallons, equivalent to 6.13 ins. of rainfall, or 14% of the total.

The drainage area included in the Ramapo plan is 141.8 miles, giving 705,000 gallons per square mile, equivalent to 14.8 ins. of rainfall, or 33.6% of the total rainfall, also taken at 44 ins. The 19 reservoirs proposed would give a storage capacity of 25,364,000,000 gallons, equivalent to 10.29 ins. of rainfall, or 23% of the total.

The 500,000 gallons per square mile assumed as the yield of the Long Island watershed is equivalent to 10½ ins. of rainfall, or 24.4% of the average yearly rainfall of 43 ins. The proposed storage would be effected by eleven ponds, with a combined capacity of 400,000,000 gallons, which is equivalent to only 0.12 ins. of rainfall.

The total cost and total annual charges, respectively, for each of the plans is as follows: Housatonic, $18,382,302 and $725,793; Ramapo, $14,630,206 and $588,548; Long Island, $24,500,000 and $1,424,742. The annual charges under the Long Island plan include $393,474 for pumping, for which there is no corresponding item in the other schemes.

In submitting the reports of Messrs. De Varona and Worthen to the Common Council of Brooklyn, Mr. Alfred T. White, the Commissioner of City Works, commented upon the relative estimates of costs as follows:

As to the costs, each engineer is responsible for his own figures. For Long Island the basis of calculation is derived from knowledge of previous experience under similar conditions, but with allowances for increased costs at the present time, which seem to me over liberal. For the Ramapo and Housatonic watersheds the same basis for calculations does not exist, and the estimates are, in my judgment, relatively too low.

I find also that experts differ as to the safest method of conveying the water from the Ramapo shed beneath the Hudson river, and similar difficulties would arise in connection with both the Ramapo and Housatonic systems at the crossing of the Bronx Kills, Little Hell Gate and Hell Gate. In 1888, Mr. John R. Bartlett and others made a proposal to the city of New York to furnish a supply from the Passaic. Mr. Herschel, Mr. Fteley and Capt. Symons, all expert engineers, united in a report to Mr. Bartlett in September, 1887, in which they state:

"We are of the opinion that this conveyance of water under pressure from the New Jersey shore into New York city must, to insure permanence, be made by means of pipes or conduits laid so as to be at all times accessible, inside of a tunnel or tunnels driven under the channel of the river."

Without undertaking to pass any opinion on the engineering question, it is evident that such construction as these engineers advise would add heavily to the cost of both the Ramapo and Housatonic systems, as estimated by Mr. Worthen, but especially, of course, to the former.

As to the part of the costs which relate to the acquisition of land and water rights and the damage to result from the diversion of water, I am again of the opinion that the estimates on the Long Island shed are relatively much higher than on the Ramapo and Housatonic sheds and the same appears to be true as to the costs of maintenance.

As to rights on the Ramapo watershed, Mr. Bartlett claimed in the printed volume published in 1888, from which I have already quoted, that the New Jersey Society for the Establishing of Useful Manufactures, owned the right to dispose of all surplus waters in the Passaic watershed, to which the Ramapo is tributary. I understand that claims are also asserted by other companies on a part of the Ramapo territory. I am somewhat doubtful as to the validity of those claims in the district treated, but if such rights exist they could of course be condemned by the city from the corporations, in the same way as if they belonged to the owners of adjacent lands.

In the case of the Ramapo, which flows into New Jersey, and of the Ten Mile River, which flows into Connecticut, no allowance has been made for difficulties likely to arise in both cases from hostile action by the neighboring States. The cities and towns in northern New Jersey assert their need, in the near future, of the entire supply from the tributaries of the Passaic.

It is also probable that complications might arise with the city of New York, should Brooklyn look to the tributaries of the Housatonic. A survey, covering a part of the same territory, tributary to the Housatonic, which is proposed by Engineer Worthen to be taken by Brooklyn, was made by the engineers of the city of New York in 1879, and since the present investigation was begun, the Croton Aqueduct Commission has recalled attention to the desirability of this territory as an annex to the Croton watershed.

Apart from these apparent difficulties, which might cause great delays, the matters I have instanced as affecting the cost of construction and maintenance and acquisition of land and water rights, together with allowance for prevention of pollution, etc., would materially increase the first cost of a supply from either the Ramapo and Housatonic sheds, perhaps even to fully the figure given by Engineer de Varona for the Long Island shed. The figure is not excessive for any of these schemes when compared with the cost of the present supply for the city of Brooklyn, or of other supplies of similar extent elsewhere, and if it be in error it is better that the error should be on the side of safety.

Engineer de Varona states that, while the mill privileges on Long Island are of little value, it may be costly to obtain land and extinguish water rights, owing to the holding of some of the best streams by wealthy clubs and individuals, but this, I think, is fully covered by his estimates. Opposition to the scheme to take water from Long Island might come from the villages along the line of the extension, but the city should undertake the water supply of these villages, and could provide it more cheaply and efficiently than could separate water companies in each locality. The plan proposed for this extension east of Massapequa is made for high-pressure conduits, and would admit of such service.

In adopting either the Ramapo or Housatonic shed, Brooklyn would have the advantage of drawing water from two directions, thus affording a better insurance against stoppage of supply in event of damage to either conduit through design or accident; while the expense of properly policing such a divided system would be greater than if the lines extended in only one direction. It may also be properly said in advocacy of the Long Island shed that it is the largest of the three within the State and that the supply to be derived therefrom could easily be made to considerably exceed the 100,000,000 gallons proposed. In the case of the Housatonic shed, within the State of New York, it seems that the amount named could not be much increased and in the case of the Ramapo can only be obtained by the addition of other watersheds.

It is a strong argument in favor of the Long Island system that it can be built in sections, and that the supply would thus become available both for use and for revenue from year to year, while the other systems would need to be practically completed before becoming of use. If the improvement of our city in other directions should keep its debt close to its limit, this question of initial outlay would become a still more potent consideration. Against it, weighing heavily on the other side, it is to be noted that the annual cost of maintaining the Long Island system is much greater than in the other cases, owing to the need of pumping all the water from the low coast level up into the Ridgewood Reservoir. Taking the costs of the three plans as made up in the annexed reports, the first outlay would be decidedly least in the Ramapo scheme of supply, and if by equalization of estimates the first costs of the three plans be closely approximated to each other, the Long Island plan would still remain the most costly in operation.

Apart from all considerations of costs we are compelled to recognize that Jersey City and its neighbors need water now and that New York city will need further increase soon, as well as that our neighbors on Long Island beg us to go elsewhere for a supply. The policy of Brooklyn should not be a selfish one but should duly weigh all these conflicting interests.

After the above discussion Mr. White proceeds to consider the possibilities of putting down wells on Long Island to a depth of 150 ft., a few flowing wells having been secured in connection with the present supply at this depth. These wells pass through 50 to 60 ft. of clay into very coarse gravel, and it is thought that they might be developed without affecting the supply from other sources. Further investigations are needed to determine what may be expected from such wells.

Next Mr. White mentions the Delaware River, at Port Jervis, N. Y., suggesting a supply of 1,000,000,000 gallons a day for the whole metropolitan district. On this point he says, in part:

As a source of large magnitude the Delaware is much nearer than the Hudson, at Glens Falls, or than Lake George, and it is at a higher elevation above the sea. Its drainage area within the State of New York, 3,600 sq. miles at the junction of the Neversink, near Port Jervis, as compared with 2,812 sq. miles of drainage area of the Hudson above Glens Falls. Port Jervis is 87 miles from Jersey City by the Erie Railroad, but less than 60 in a straight line. The Delaware watershed is well wooded and its population above Port Jervis was only 31 per sq. mile in 1890, having actually diminished since 1880.

Mr. White concludes his report by a discussion of proposals for water to be furnished by private corporations. He alludes to an offer made to Brooklyn by the Ramapo Water Co., in 1887, naming $430,000 a year as the price for 20,000,000 gallons a day, or about $60 per 1,000,000 gallons; and to the offer made to New York City, in 1888, by John R. Bartlett and associates to furnish water at $75 per 1,000,000 gallons. He concludes as follows:

Two things are to be noted about all such proposals. The first is that it is difficult to provide sufficient security for the case of failure, either in time, quantity or quality; and the second, that the resultant cost to the city is far greater for each million gallons than the cost through municipal ownership on any of the plans submitted by the engineers, which on the highest basis of estimate would not exceed $39 per 1,000,000 gallons, and on the lowest would be under $20. Private corporations cannot borrow money as cheaply as cities and states.

The experience of London is sufficient warning against the folly of allowing the possession of the main sources of a city's water supply to pass into private hands, and it is too plain to need argument that cities or states should control their sources of water supply not indirectly, by contract for a few years, but directly by ownership for all time.

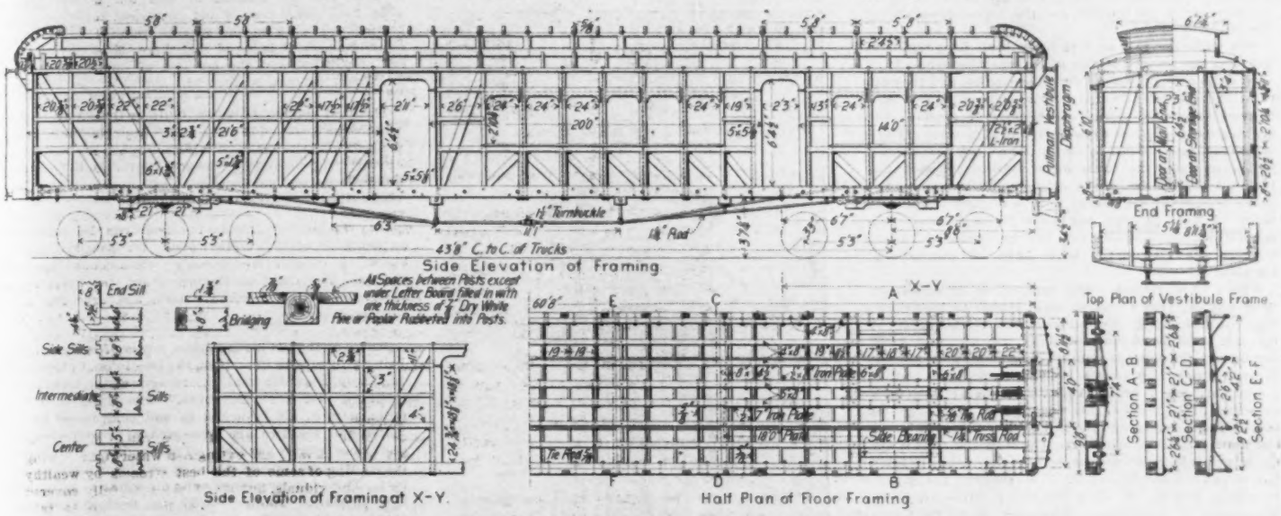
A memorial to the late Gen. O. M. Poe, M. Am. Soc. C. E., Engineer Corps, U. S. A., in the shape of a bronze tablet, at Sault Ste. Marie, Mich., to commemorate his work on the new canal and locks, has been proposed by the Lake Carriers' Association.

ANTI-TELESCOPING MAIL CAR; B. & O. R. R.

The greater liability to serious injury of the cars next to the locomotive in case of collisions is well known; and the accident records of the Railway Mail Service bear witness to the fact that the mail clerks who work in the railway postal cars (which are usually at the head of the train), are among the most frequent victims in case of train accidents. In view of these facts the advantages of adopting an especially strong framing for railway postal cars are evident. We illustrate herewith an "anti-telescoping" postal car, which has recently been designed by Messrs. R. B. Campbell, General Manager of the Baltimore & Ohio R. R., and M. E. W. Grieves, Superintendent of the Car Department of the same road. A car has recently been built to these designs at the B. & O. R. R. shops. This is the second car designed by Mr. Campbell, his combination stock, coal and freight car having been described and illustrated in our issue of April 25, 1895.

The most prominent features of the design are the unusual amount of diagonal bracing in the side frames, and the unusual number of sills, while the spring buffer platforms and the provision for vestibule connections will prevent the adjoining cars from getting out of line vertically in such a way as to let the frames cut through the lighter upper works, which is the way in which some of the worst cases of telescoping occur. There are no end platforms. At the storage room end of the car is a door way, while the sorting room end has a trap door 29 ins. high, opening inwards under the sorting table. There are two doors in each side, and ample window space is provided.

The car is 60 ft. 8 ins. long over the end sills and 9 ft. 8 ins. wide over the side sills. There are eight longitudinal sills of yellow pine, including two side sills 8×8 ins. (each built up of two timbers 4 × 8 ins. bolted together), two center sills 5 × 8 ins., and four intermediate sills 4 × 8 ins. Between the sills are bridging pieces 1¼ × 6 ins. at intervals of 18 to 20 ins. An iron plate ⅜ in. × 7 ins. and 18 ft. long is bolted between the two timbers of the side sills at the ends of the car, and a similar plate is bolted to the outer side of each center sill. The end sills are of white oak 8 × 8 ins., with an angle iron 6 × 6 × ⅝ ins. on the lower corner. In front of the sill is a platform timber or bumping beam 7 ins. thick, 6½ ins. wide at the ends and 12 ins. at the middle. The body bolsters are double, each being a timber 6 × 8 ins., these timbers carrying the center plate and the bridges for the side bearings. There are four cross-ties or needle-beams 4½ × 8 ins., the two middle ones being trussed. The frame is trussed by four 1¼-ins. truss rods, two (on the outer side of each center sill) extending the whole length of the frame and being secured by nuts outside the end sills, and two (under the side sills) extending only to straps in front of the bolsters, to which they are secured by pins. The truss depth is 17 ins. below the sill and the spacing of the truss-rod posts is 11 ft. 1 in. for the middle posts and 6 ft. 3 ins. for the second posts. The ends of the rods are upset and threaded and connected by 1¼-in. turnbuckles. It would seem to be almost impossible to smash or break up this floor framing in any ordinary collision. The floor has a lower layer of 1⅛-in. yellow pine laid diagonally and an upper layer of the same laid longitudinally. The posts are mainly 2¾ × 3 ins., or 2¾ × 5 ins., in two pieces, let into the outer timber of the side sill and the top timber 2¾ × 6 ins. Tie rods ⅝-in. diameter are bolted through the sill and top rail, and some of the posts are strengthened by an angle iron ⅜ × 2 × 2½ ins., one leg being bent horizontally at top and bottom and spiked or bolted to the side sill and top rail. The long braces or collision struts are 1¾ × 6 ins., and those at the ends of the side frames are seated in the bent ends of the vertical angle irons. The smaller side braces are 5 × 1¾ ins., with the upper ends resting against the bent ends of ⅝-in. rods, which are bolted through the side sills. The belt rails are 4×1⅛ ins. and the side rails 3× 1⅛ ins. The doorways are 2 ft. 3 ins. and 2 ft. 11 ins. wide and 6 ft. 4⅛ ins. high, and the window openings are 24 × 34⅛ ins. in the clear. The roof carlines are 1¾ ins. thick, spaced about 13 to 16 ins. apart, every fifth carline being formed of two of these pieces with a ⅜-in. plate between them.



CAMPBELL'S MAIL CAR, WITH ANTI-TELESCOPING FRAMING; BALTIMORE & OHIO R. R.

The equipment includes Pintsch gas lamps, with gas cylinders holding a supply for 45 hours, oil lamps for emergency, the Gold steam-heating system in connection with Baker heaters, Westinghouse brakes and train signal, Buckeye automatic couplers, Westinghouse iron brakebeams for the middle wheels of each truck, and wooden brakebeams plated with iron for the outside wheels.

The car is carried on two six-wheel passenger trucks, with 33-in. wheels, the journals being 4¼ × 8 ins. All the wheels are braked. The truck wheelbase is 10 ft. 6 ins., and the distance between truck centers is 43 ft. 8 ins. The general dimensions of the car are as follows:

Length over end sills	60	ft. 8	ins.
Width over end sills	9	" 8	"
Height from rail to bottom of sill	3	" 7¼	"
" " " to c. line of coupler	2	" 10½	"
" " sill to top plate	6	" 10	"
" " sill to top of roof	8	" 0	"
" " sill to top of monitor roof	9	" 6	"
Wheels, diameter	2	" 9	"
Truck wheelbase	10	" 6	"
Total wheelbase	54	" 2	"

RAIL SECTIONS AND WHEELS.*

Ever since the introduction of steel rails, both rail makers and consumers have had a very live question before them. At first, steel rails were made from small hammered ingots, passing the rolls many times at a low temperature until they had an even solid surface, but the demand was for cheap rails, and cheap processes had to be adopted to make them. The first demand was for cheap hard rails that would stand the wear better than the iron rails were

*Abstract of a paper read by Mr. Lodge at the meeting of the Engineering Association of the South, at Nashville, Tenn., Jan. 23.

doing, and the rail makers furnished them. Then, in 1875, Williams and others in England, and in 1878, Dr. C. B. Dudley, of the Pennsylvania R. R., and some other American engineers, called for a soft steel rail, and the mills supplied the desired metal, some of which would pass for either steel or iron. Roads that purchased this soft metal were doomed to disappointment, for it was soon found that a harder rail was needed, but that physical hardness and not chemical hardness was wanted. Then came several years of careful investigation in which segregation was talked about a great deal, and photo-micrography became a very interesting study. Rail makers were, in the meantime, spending thousands of dollars in improvements and experiments, with the hope of making a rail of uniform quality and one that would stand most rigid inspection. They found that they could not do it if they continued the direct process of running the molten metal direct from furnace to converter, as they were not able to make every cast the same, a cold cast giving low silicon and high sulphur, while a hot cast gave the reverse. There was also difference in the manganese oxidized. Many of the mills, especially in England, abandoned the direct method and ran the iron into pigs, then mixed the pigs so that when re-melted they represented an average of a week or more's run of the furnace. Since the introduction of the mixers the re-melting has been done away with in many mills, and at the Edgar Thomson Works they have lately abandoned the use of a 200-ton mixer and substituted one holding 600 tons. This is kept full of metal run direct from the furnace, and the converters are filled from it.

Now while the rail makers have been busy trying to improve the quality of the steel rails, the roads have been giving the rails more and more to do, and the only thing they have done to help themselves is to ask for a heavier rail, with plenty of stiffness of section, but nothing has been done to balance the additional surface wear that has been put on them. Since they commenced to use steel rails the roads have doubled the weight of the load carried by freight cars, but still continue the practice of running a wheel with a slightly coned tire, made as hard as man can make it, on a nearly flat-headed or a round-headed rail, and engineers and road-masters still discuss the best shape for the head of the rail.*

With a 30-in. chilled wheel running at 30 miles per hour, and carrying a load of from 10,000 to 18,000 lbs. on a circle of say 12 ins. radius, which is the radius of the rail sections recommended by the Am. Soc. C. E. committee, the point of contact is so small that the rail is crushed to sufficient area to support the load, and on a road carrying a heavy traffic, the rails are beat into the shape of the tread of the wheel. This would not be so bad if the structure of the rail had not been injured, but the damage has been so great that by the time it fits the wheel it is ready for the scrap pile. I beg to refer you to two rail sections by Mr. P. H. Dudley; Trans. Am. Inst. Min. Engrs., vol. 28, p. 235 and p. 767. Mr. E. W. McKenna, of the Chicago, Milwaukee & St. Paul Ry., says that by careful tests he ascertained that a rail wears out by deformation of the head, and not by actual loss of the metal. (Eng. News, Nov. 22, 1894, p. 419). A section of a 60-lb. rail removed from the track was found to have lost only .117 to .135, or about ⅛ lb. per yd.

Steel rails have done better service in Europe than here, one French road showing from 15,550,000 to 45,900,000 tons per millimeter wear, while the Pennsylvania R. R. reports a wear of from 10,300,000 to 16,709,000. This is no doubt partly due to the light rolling stock, but mainly to the use of soft wheels, which soon conform to the shape of the rail.

The writer's attention was first called to this question by noticing that rails lasted longer on redwood ties than on yellow fir ties. The inside edge of the rail base was in a few months buried in the redwood ties; the tie was, of course, soon crushed to death, but the rail conformed to the tread of the wheel, and did good service. But as we had to send 4,000 miles for ties, the tie question was a serious one. At a later date when transferred to another road that was under construction, it was decided to "spot" all ties, so that the rail would conform to the shape of the wheel. The "spotting" machine consisted of a frame set on a car with a mandril 6 ft long, on which were placed two sets of knives 5 ins. wide, set to the same angle as the cone of the wheel. The inside edge of the knife was set so that when the rail was placed against the shoulder made by the knife, the gage of the track was right. This was a great help in laying track, as the ties were always placed with ends even, and a spike on the outside of the rail always brought it up to gage. In fact, every tie was a gage, and if the rail ever left the shoulder on the tie, we were sure the track was out of gage. This could be noticed by anyone on the rear platform of the train, unless the train was running fast. The outside edge of the knife ran out and left no shoulder, except where the tie was winding, in which case the knife was run deeper, in order to get a bearing surface the full width of both rail and tie. The ties were "spotted" as fast as they could be loaded on a car. The power required is about the same as that used for an ordinary portable pile driver. It requires one man to run the machine, who, with the assistance of an ordinary section gang, can spot the ties about as fast as they can be properly inspected. The benefit derived from this plan was very marked near switches, as the switch ties were not spotted, and the rails on the unspotted ties wore faster than the rails laid on "spotted" ties. This was also shown on two or three bridges, where in the rush to get the track over they neglected to spot the bridge ties. It is the writer's opinion that the "spotting" of the ties increased the life of the rail about one-third. There was also, of course, some saving in the ties.

*The form of head represented in the standard sections recommended by the committee of the American Society of Civil Engineers is now very generally considered as the best, and these rails are extensively used.—Ed.

GALVANIZED STEEL WATER TOWER; LYLE, MINN.

We illustrate herewith a water tower recently erected at Lyle, Minn., which is of particular interest for being constructed entirely of galvanized steel. The tower was designed and built by the Challenge Wind Mill & Feed Mill Co., Batavia, Ill., and is said to be the first galvanized metal tower ever built. Since its completion a similar tower has been put under construction at Alexis, Ill.

Galvanized Steel Water Tower for Lyle, Minn., Water-Works.

Challenge Wind Mill & Feed Mill Co., Batavia, Ill., Contractors.

The tower at Lyle, Minn., is built of twelve Larimer columns braced together as shown, and is 80 ft. high from the top of the foundation stones to the bottom of the tank. The tank is 24 ft. in diameter, with a capacity of 2,000 gallons, and is surmounted by a galvanized steel pumping windmill, which pumps water from an artesian well 100 ft deep. The point of chief interest is of course the process of galvanizing the steel-work, or more correctly, the process of cleaning and immersing in a zinc bath, which is usually called galvanizing. The immersion is made after all the shop-work has been done and with as large pieces as possible. For the Lyle, Minn., tower the longest member galvanized was 28 ft., and it weighed 26½ lbs. per foot, and for the Alexis, Ill., tower Larimer columns 22 ft. long and weighing 42 lbs per foot were immersed. The galvanizing kettle holds 35 tons of zinc, and will take in beams 48 ins. wide and 21 ft. 6 ins. long. The extra cost of galvanized work for these towers is about $18 per ton.

The Maryland Road League will submit two bills to the General Assembly of that state with a view to reform in highway construction. One bill would establish a state engineering department, at a cost of $25,000 annually, and the other would place the supervision of the roads in each county in the hands of a commission of three to five persons appointed by the county commissioners, and who would serve without pay. Under existing law the county commissioners are expressly authorized to employ skilled engineers in road construction, but they fail to do so owing to the cost. The purpose of the first bill is to have the state pay the engineers, and make their services available to the counties free of cost. The League appreciates the fact that the money now expended on road repair in Maryland is mainly wasted through ignorant methods, and it hopes by the passage of this bill to have future work done under trained and competent supervision. By putting this work in the several counties under unpaid commissioners, it is hoped that these offices may be taken out of politics, and the services of public-spirited and intelligent citizens be secured.

The first pumping engine built by George H. Corliss which was installed in 1872 at the Hope reservoir, Providence, R. I., is about to be replaced by a Holly compound engine. The capacity of the new engine is to be 5,000,000 gallons per day raised 115 ft. high, and the duty guaranteed is 110,000,000 ft. pounds.

The Washington aqueduct tunnel can be completed, on the basis of the original plans, for $900,000, and the board of experts unanimously recommends that this be done. The Chief of Engineers and the Secretary of War indorse this recommendation, and urge that it be done at once.

A new method of utilizing the power of a water fall is being projected in Canada at the Dominion Cotton Mills at Magog, near Montreal, according to a statement in the "Mining and Scientific Press." The water is to flow down a pipe, air is sucked in and compressed by the water, and the two are separated by gravitation in a storage or supply chamber. The compressed air is then transmitted to the mill where it will be utilized by motors. This plan for compressing air seems to be nothing more than the "trompe" which was used in Spain hundreds of years ago for blowing air into catalan forges. It is a very inefficient method. Direct compression of the air on the hydraulic ram principle would be a far better method.

The production of pig iron in the United States in the year 1895 was 9,146,308 gross tons of 2,240 lbs. each, according to the official statistics just issued by the American Iron & Steel Association. This product surpasses that of 1890, which was hitherto the year of largest production in the history of the trade by 243,695 tons. The production of pig iron in the ten years previous to 1895 was as follows:

1885	4,044,526 tons.	1890	9,202,703 tons.
1886	5,683,329 "	1891	8,279,870 "
1887	6,417,148 "	1892	9,157,000 "
1888	6,489,738 "	1893	7,124,502 "
1889	7,603,642 "	1894	6,657,388 "

Pennsylvania produced 49 76 % of the total product of the United States in 1895, and Allegheny County 43.7 % of the total product of Pennsylvania. The production of Bessemer pig iron in 1895 was 5,623,645 tons, against 3,808,567 tons in 1894. The stocks of pig iron unsold in the hands of manufacturers or their agents on Dec. 31 1895, amounted to 444,332 tons, or only about two weeks' production.

The production of anthracite coal in the years 1894 and 1895, as reported by each carrying company, was as follows:

	1894.	1895
Reading	8,289,088	9,905,0 9
Lehigh Valley	6,424,676	7,360,454
Lackawanna	5,997,989	6,129,260
Jersey Central	4,847,885	5,388,194
Pennsylvania	4,727,575	5,025,645
Delaware & Hudson	3,997,059	4,347,843
Coxe Brothers	1,633,368	1,905,784
Erie	1,669,827	1,820 038
Pennsylvania Coal Co	1,705,197	1,746,832
Susquehanna & Western	726,116	1,492,244
Ontario & Western	1,372,365	1,424,407
Total	41,391,199	46,545,671

During a part of the year 1894 the tonnage of the New York, Susquehanna & Western was included in that of the Lackawanna.